

# **EXHIBIT 1**

**UNITED STATES DISTRICT COURT  
DISTRICT OF NEW JERSEY**

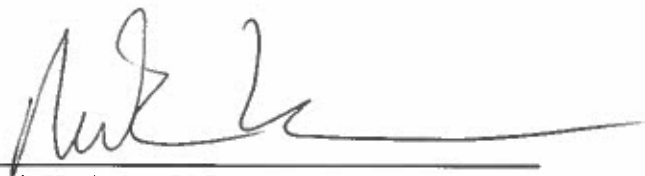
**IN RE JOHNSON & JOHNSON  
TALCUM POWDER PRODUCTS  
MARKETING, SALES PRACTICES,  
AND PRODUCTS LIABILITY  
LITIGATION**

**MDL NO. 16-2738 (FLW) (LHG)**

***THIS DOCUMENT RELATES TO ALL CASES***

**RULE 26 EXPERT REPORT OF  
MARK KREKELER, PHD**

Date: November 16, 2018

  
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Mark Krekeler, PhD

### **EXPERT REPORT OF MARK KREKELER, Ph.D.**

I am providing the following preliminary report concerning my expert opinions in this case. I understand that I will have the opportunity to supplement this report, if necessary, after discovery is complete. I offer these opinions with a reasonable degree of certainty within the confines of my discipline as an expert in mineralogy, geology and environmental geoscience.

I obtained a Ph.D. in the field of Geotechnical Engineering and Earth Science in 2003 from the University of Illinois at Chicago. I currently serve as a tenured associate professor in the Department of Geology and Environmental Earth Science at Miami University in Oxford, Ohio and on Miami University Hamilton campus. My work is primarily focused on mineral properties, particularly phyllosilicates, kyanite, metals, oxides, oxyhydroxides, phosphates, and industrial minerals in igneous, sedimentary, and metamorphic systems; and mineral-based geotechnologies. I have authored or co-authored several publications addressing issues related to mining (e.g., Burke et al. 2017; Schellenbach and Krekeler, 2012; Geise et al., 2011; Krekeler et al. 2010; Krekeler et al 2005; Krekeler et al. 2004; Krekeler 2004), as indicated in my attached curriculum vitae. I also have served as a consultant for various mining companies, advising them on their procedures and techniques for mineral sampling, as well as providing in-depth analysis of their ore minerals and waste materials. I teach a wide variety of courses for both undergraduate and graduate students including courses focusing on mineralogy, geochemistry, ore geology and analytical techniques. In addition to my course offerings, I work extensively with undergraduates and graduate students on numerous projects often involving transmission electron microscopy, scanning electron microscopy and bulk chemistry.

I have been asked to examine whether Imerys<sup>1</sup> and Johnson & Johnson acted in accordance with industry standards and and/or maintained adequate quality control in mining talc for use in cosmetic talcum powder products (Johnson's Baby Powder and Shower to Shower). In my opinion, they did not.

The documents, depositions and other materials reviewed thus far indicate that:

- (1) toxic constituents were and are known to both companies to occur in their respective ore and resulting products, including asbestos, heavy metals and asbestiform habit fibers;
- (2) there are longstanding analytical inadequacies implemented by Imerys and/or Johnson & Johnson that are inconsistent with common reasonable industry practices as to the identification and exclusion of harmful constituents in their mine product;
- (3) neither Johnson & Johnson nor Imerys had reasonable practices in place to reject any product due to failure to meet specification as to asbestos, asbestiform fibers, or heavy metals; and
- (4) as a result, it is scientific reasonably probable that consumers were exposed to those toxic constituents in the final cosmetic products.

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<sup>1</sup> When referring to Imerys, I also refer to its predecessor companies Luzenac America, Inc. and Rio Tinto Minerals.

Below, I provide evidence that Imerys and Johnson & Johnson mined, modified, refined, and produced talc-based products containing hazardous materials over a period of several decades using inadequate steps and procedures. This report is a qualitative assessment of mineralogical, geochemical and geologic data and problems. To reach the opinions I set forth below, I reviewed documents, both those produced by the defendants as well as deposition transcripts of company witnesses. I have also conducted an extensive review of peer-reviewed literature and other works, such as geologic survey documents and government agency information. Finally, I rely on my experience and methodology in both the academic and private sector in preparing my opinions.

To date, I have participated in one other litigation as a paid expert. The case dealt with patent infringement and was located in Canada. For my expert services, I charge \$125 per hour for writing, report preparation, and data evaluation, and \$100 per hour for document evaluation, reading, note taking, and correspondence.

## **RELEVANT ISSUES CONCERNING THE OVERALL NATURE OF TALC**

### **Talc**

Talc<sup>2</sup> is a mineral derived almost exclusively from metamorphic deposits. Metamorphic rock, a type of geological deposit, is generally recognized as one of the more complex deposits, stemming from numerous geologic processes such as the addition of heat, pressure, and fluids that change a precursor rock (often referred to as a protolith) into a metamorphic rock. This process occurs over several tens of millions of years. Metamorphic rocks can be subjected to multiple geologic events that modify the rock at each stage of development, adding or removing elements and changing mineral composition. Metamorphic rocks are dynamic in the context of geology and generally require a higher level of technical and manufacturing expertise to achieve mineral purity in derived products.

Talc is refined from ore by different mineral engineering methods or other treatments for use in various product applications. Talc is used in numerous products because of its low mechanical strength, surface characteristics and other properties. Talc can have, and commonly does have, natural impurities. These impurities may be innocuous (e.g. pure dolomite, chlorite), or may be hazardous, as with asbestiform minerals and toxic metals. Responsible mines, consistent with industry standards, should closely monitor the quality of their industrial mineral products to meet customer expectations, as well as verify the absence of hazardous materials in the product line.

Talc is a phyllosilicate mineral. The phyllosilicate mineral group are minerals with a topology of layered structure types. Talc's crystal structure is classified as a 2:1 phyllosilicate, having two tetrahedral sheets of hexagonal SiO<sub>4</sub> polyhedra bonded to a single octahedral sheet, dominated by Mg cations commonly with lesser amounts of Fe, Ni, and several other transition metals (Fig. 1). Talc's 2:1 layers are bonded or stacked perpendicular to the sheets along the

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<sup>2</sup> Extensive peer-reviewed literature exists on talc as well as several publications issued by government geological surveys. These publications describe the geology, mineralogy and geochemistry of the numerous talc mines in the United States and globally. The level of detail of geologic and mineralogical investigations varies significantly amongst this body of literature.

crystallographic axis. The bonding that holds the 2:1 layers together is weak, which explains talc's weak mechanical strength and characteristic softness.<sup>3</sup>

Figure 1:<sup>4</sup>

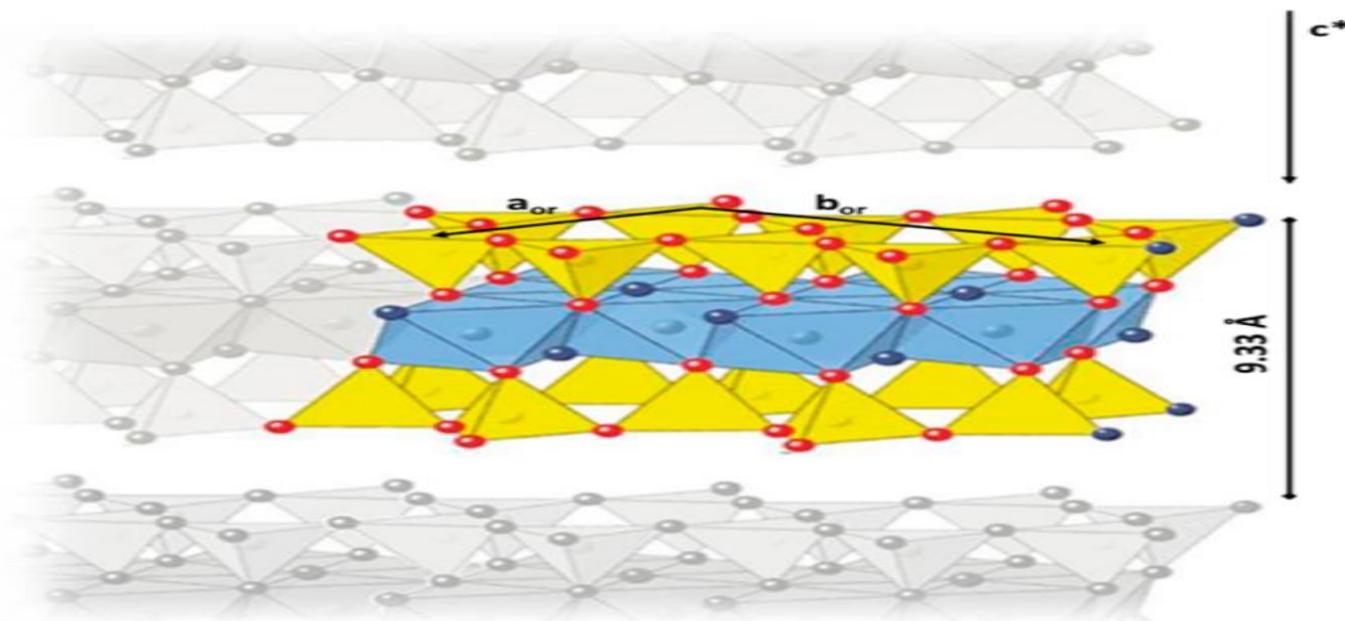


Figure 1, modified from Dumas et al. (2015), shows repeating 2:1 phyllosilicate layers comprised of an octahedral sheet (blue) and tetrahedral sheets (yellow). The yellow balls within the yellow triangles correspond to silicon atoms, while the light blue balls correspond to magnesium atoms dominantly but also iron atoms, nickel atoms and other heavy metal substituents. The dark blue balls are hydroxyl (OH<sup>-</sup>) groups and the red balls are oxygen atoms. Crystallographic directions (a,b,c) are depicted as well.

Disorder in talc's crystalline structure refers to turbostratic stacking, collectively referred to as a random layer stacking. Random layers are layers of a crystal structure that are arranged parallel to one another, but random in translation perpendicular to the layer (e.g., Warren, 1941). Most talc exhibits some or extensive random layer stacking (e.g., Moore and Reynolds 1989).

Talc can occur in a fibrous habit. The World Health Organization ("WHO"), as well as other national and international agencies, have designed and defined a mechanism of determining the amount of respirable fibers. These fibers can be inhaled into the lower lungs based on their length and diameter, producing effects linked to significant health risks in humans. (IARC, 2012. These fibers are referred to as being in the asbestiform habit, which is discussed below. Notably, nonasbestiform minerals such as large crystals of tremolite or anthophyllite could be modified

<sup>3</sup> Evans and Guggenheim (1988) reviewed talc in detail, and explained details of the crystal structure variants (polytypes) and crystal chemical properties.

<sup>4</sup> Dumas, A., Mizrahi, M., Martin, F. Requejo, F.G. (2015) Local and Extended-Order Evolution of Synthetic Talc during Hydrothermal Synthesis: Extended X ray Absorption Fine Structure, X ray Diffraction, and Fourier Transform Infrared Spectroscopy Studies Cryst. Growth Des. 15: 5451–5463.

during processing and be turned into asbestiform particles with the same health risks as asbestos, due to the size, morphology and chemistry of the modified particles.

### *Asbestos*

The term “asbestos” is used to broadly categorize a class of minerals. Asbestos is a naturally occurring mineral that can be in close proximity to talc in mines around the world. The Agency for Toxic Substances and Disease Registry (“ATSDR”) defines asbestos as six fibrous minerals in two general classes: serpentine and amphibole. The serpentine class includes chrysotile (also known as white asbestos), and the amphibole class includes amosite (brown asbestos), crocidolite (blue asbestos), actinolite, anthophyllite, and tremolite.

Minerals in the asbestos category can occur in two “habits,” or characteristic shapes: asbestiform and nonasbestiform. Asbestiform refers to a mineral that has grown into a fibrous aggregate of long, thin and flexible crystals that readily separate into smaller crystals of a similar length to width aspect ratio. The term fiber is an important qualifier for asbestos, as some amphibole minerals may not occur in a fibrous habit. Chrysotile minerals always occur in a fibrous habit, and there are asbestiform and nonasbestiform varieties of tremolite, actinolite, crocidolite and anthophyllite. An asbestos mineral that breaks or cleaves into fragments, rather than breaking into slender fibers, has a “nonasbestiform habit.” (NIOSH, 2011; IARC, 2012; IRSST, 2012).

Asbestiform and nonasbestiform versions of the same mineral can occur together. (NIOSH, 2011). Nonasbestiform minerals may have the same chemical formula as the asbestiform variety, but lack the carcinogenic effects commonly associated with asbestos material. (IARC, 2012). However, nonasbestiform cleavage particles can correspond to the definition of respirable fiber as defined by WHO and due to its morphology can have potentially dangerous health effects. (NIOSH, 2010; IRSST, 2012).<sup>5</sup>

Whether a fiber is considered asbestiform is primarily dependent on its aspect ratio, this ratio allows scientists to index fibers that are potentially dangerous to humans. The aspect ratio counts fibers that are longer than 5  $\mu\text{m}$ <sup>6</sup> with a length-to-width ratio of 3:1 or more. (IARC, 2012; MSHA, 2008; OSHA, 1995; Blount, 1991). NIOSH adopted an aspect ratio of 5:1. It is this ratio of length to width that make the fiber needle-like and contributes to deleterious health effects. There are also other iterations of aspect ratios which were considered, but not included in this report, because those ratios are delineated for industrial and environmental safety related purposes.

### *Formation of Talc deposits and inherent asbestos impurities*

Talc forms in the earth in metamorphic terranes, and the difference in metamorphosed mafic and ultramafic rock deposits show the complexity of talc ores at different levels (e.g., Berg, 1977). Italian mines from which Johnson & Johnson and Imerys obtained talc for cosmetic production were of ultramafic origin. Vermont mines relevant to this litigation are of mafic and ultramafic

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<sup>5</sup> The Robert-Suave Research Institute in Occupational Health and Safety (“IRSST”), Studies and Research Projects Synthesis of Knowledge on Tremolite in Talc. (Montreal: 2012). Available: <http://www.irsst.qc.ca/media/documents/PubIRSST/R-755.pdf> [accessed last Sept. 19, 2018].

<sup>6</sup> For context, 5  $\mu\text{m}$  equals .00019685 inches.

origins, while the Chinese mines of interest are of metasedimentary origins. Every geologic environment on earth experiences a unique geologic history in the context of time, pressure, temperature, geochemistry and mineralogical evolution (e.g., Hazen, 2008). Thus, each talc mine has its own character, as well as its own contaminants. As a result, natural talc formation is commonly accompanied by veins of other minerals, including asbestiform minerals like tremolite and serpentine (Deer, Howie and Zussman, 2013).<sup>7</sup> Additionally, talc deposits may be formed by replacement of amphibole and olivine, the assemblage of which may include minerals like tremolite, anthophyllite, chlorite, magnesite, dolomite, and quartz.”<sup>8</sup>

Asbestos minerals including chrysotile, tremolite, actinolite and anthophyllite are common in talc ores. The presence of asbestos in talc deposits has been common knowledge amongst industrial mineral companies, research professionals and mining geologists, dating back to as early as the 1930’s (Hess, 1933). Talc and chrysotile are associated with each other in talc deposits at the micrometer or nanometer scale,<sup>9</sup> making separation impossible during the mining and manufacturing process.<sup>10</sup> In a classic paper by Veblen and Buseck (1979), the authors utilized transmission electron microscopy data to show how amphibole, chrysotile and talc can be intimately associated with each other at the nanoscale.

Metamorphic systems are by definition dynamic, with temperature, pressure, fluid and mechanical conditions varying over time. Reactions may also be incomplete, meaning there may not be enough geologic time or other chemical component to drive the reaction to completion, as discussed in Deer, Howie and Zussman (2013). Reactions can also progress for some period and then revert to the asbestiform mineral chrysotile, because of changes in geologic conditions such as temperature, concentrations of CO<sub>2</sub> and other kinetic factors difficult to define.

These incomplete reactions, and others referred to in Chernoskey et al. (1988) and Evans (2004), demonstrates the potential for asbestiform minerals to occur in talc deposits. Essentially, from these incomplete reactions asbestos impurities can result, due to precursor minerals that do not fully convert to talc, resulting in transition fibers that possess characteristics of both minerals.<sup>11</sup> Transition fibers such as actinolite (or anthophyllite) talc have been found in the Argonaut/Hamm mines in Vermont. IMERYS 427428; IMERYS 427326; IMERYS 427419; IMERYS 436951; IMERYS 418940; IMERYS 435988; IMERYS 435992; IMERYS 435996; IMERYS 436000; IMERYS 238270; IMERYS 436951; IMERYS427291. Asbestiform minerals in talc deposits is pervasive. A 1977 thesis by Barry Seymour, (JNJ 000272469), describes the complex mineralogical development of the specific talc ore, providing how many different minerals and mineralogical formations are involved in the process. Seymour states that through this process, talc and chlorite can, over time, transform into serpentines and amphiboles, the latter including tremolite, both mineral serpentine and amphibole have been recognized as hazardous asbestiform minerals (JNJ 000272500-1).

<sup>7</sup> Deer W.A., Howie R.A., Zussman J. (2013) An introduction to the Rock-forming Minerals. 3rd edition, The Mineralogical Society, London, p. 145, 149, 151, 164-5.

<sup>8</sup> *Id.* at 204-207.

<sup>9</sup> For scale, a micrometer (also called a micron) is 1000 times smaller than a millimeter, and a nanometer is 1000 times smaller than a micrometer.

<sup>10</sup> For example, Evans (2004) discusses the stability of serpentine minerals in general and a major point of this paper is discussing the stability of chrysotile. In Evans (2004), an extensive body of literature is discussed that indicates that talc and chrysotile are commonly associated.

<sup>11</sup> Transitional fibers are often referred to “cinders” in many of Defendants’ documents.



*Common toxic metals of interest are likely to occur in talc*

Typically, mining companies look to agencies like the International Agency for Research on Cancer (“IARC”), the Centers for Disease Control & Prevention (“CDC”) and the National Toxicology Program (“NTP”) for guidance regarding setting, maintaining and following safe levels of hazardous toxic metals in the ore and products. To date, IARC has classified chromium (Cr) and nickel (Ni) as human carcinogens, and cobalt (Co) as a Group 2B carcinogen, or a possible carcinogen to humans.<sup>12</sup> These metals were commonly reported at levels above specifications in ore used in talcum powder products. Defendants should closely monitor and reject mineral product with toxic metals in concentrations above acceptable levels. Johnson & Johnson issued Standard Operating Procedures with maximum acceptable levels of certain heavy metals. IMERYS 235927; JNJ TALC000205528; JNJ 000057833.

*Talc and talc deposits and their association with toxic metals*

Talc, in its natural state, can be associated with heavy metals toxic to humans. Heavy metals are defined as metals with a density greater than 5.0 g/cm<sup>3</sup>, whereas toxic metals are defined as having some degree of biological harm associated with them. Under these circumstances, harm is defined as the interruption of normal biological processes, such as cell metabolism and growth, or inducing some negative health outcome, like cancer or other illnesses. Most heavy metals are toxic, but not all. ATSDR provides a standard approach for defining toxicity designations.<sup>13</sup> Heavy metals and toxic metals are terms sometimes used interchangeably, but for purposes of this Report, the heavy metals discussed are considered toxic.

Mafic and ultramafic rocks, the talc precursor material noted above, are characterized by higher amounts of iron, magnesium, chromium, nickel, cobalt and lower amounts of silica. Arsenic is also associated with these rock formations. Consequently, through the metamorphic process minerals such as talc would contain appreciable amounts of such metals, as well as others. The distribution of these metals is unpredictable, appearing spatially localized in a given ore deposit, diffuse throughout the ore deposit, or both.

Academic and research literature have long-recognized many toxic metals commonly found in talc as known or possible carcinogens, including: Chromium (Cr), nickel (Ni), cobalt (Co), arsenic (As)<sup>14</sup> (e.g., Cralley, 1968; Rohl, et al., 1976; Gondal, et al., 2012; Rehman et al., 2013; FDA, 2017; Sunderman, 1978; Stohs and Bagchi, 1995; Hayes, 1997). Below are toxic

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<sup>12</sup> IARC’s 2B classification has been defined as follows: “A positive association has been observed between exposure of the agent and cancer for which a causal interpretation is considered by the Working Group to be credible, but chance, bias or confounding could not be ruled out with reasonable confidence” (IARC, 2006 (p.24)).

<sup>13</sup> ATSDR Toxic Substances Portal, Agency for Toxic Substances and Disease Registry, <https://www.atsdr.cdc.gov/substances/index.asp> (last updated Aug. 14, 2017).

<sup>14</sup> Mandal and Suzuki (2002) notes arsenic is a globally recognized toxin, linked to numerous diseases of the respiratory, pulmonary, cardiovascular, gastrointestinal, hematological, hepatic, renal, neurological, developmental, reproductive, and immunologic. Jarup (2003) reports skin cancer, stomach cancer and lung cancer from arsenic. Smith et al. (2006) reports lung cancer and bronchiectasis with in utero exposure for young adults, as well as increased mortality from lung cancer and bronchiectasis in young adults after exposure to arsenic in utero and in early childhood.



metals commonly associated with talc ore, and relevant designations by national and international regulatory bodies.<sup>15</sup>

Arsenic - Numerous organizations designated arsenic as a known human carcinogen (USEPA, 1995; NIOSH, 2012; IARC, 2012; NTP, 2016).

Chromium VI - IARC – recognizes as a known human carcinogen; EPA – recognizes as a known human carcinogen; American Conference of Governmental Industrial Hygienists – recognizes as a suspected human carcinogen; NIOSH– recognizes as a potential occupational carcinogen.

Nickel - IARC – recognizes as a known human carcinogen; EPA – recognizes as a known human carcinogen; American Conference of Governmental Industrial Hygienists – recognizes as a suspected human carcinogen; NIOSH– recognizes as a potential occupational carcinogen.

Cobalt - IARC – recognizes as possibly carcinogenic to humans.<sup>16</sup>

## **EVALUATION OF THE TESTING AND SAMPLING ASPECTS OF DEFENDANTS AS WELL AS THIRD PARTIES**

### **Sources of Talc**

Talc used in Johnson & Johnson talcum powder products was sourced from talc mines in Italy, Vermont and China over different periods.

Briefly, the chronology of talc ore used for cosmetic products, including Johnson's Baby Powder and Shower to Shower:

- 1926-1941: Val Chisone mine, Italy, Product Name - E.G.T. Extra 00000
- 1941-1946: California and Val Chisone (75%-25% respectively) – Product Names – California “P Special” and E.G.T. Extra 00000<sup>17</sup>
- 1946 - 1964: Val Chisone mine, Italy, Product Name - E.G.T. Extra 00000<sup>18</sup>
- 1964 - 1975: Hammondsville Mine<sup>19</sup> milled at the West Windsor Mill, Vermont, Product Name – Windsor 66<sup>20</sup>

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<sup>15</sup> (NTP, 2016); (NIOSH, 1975); (ACGIH, 2017); (IARC, 2006); (IARC, 2012); (NIOSH, 2012).

<sup>16</sup> Salnikow and Zhitkovitch (2008); Cohen et al., (1993); Costa (1997); Costa and Klein (2006); Cameron et al. (2011); Barceloux (1999); Zhao et al. (2009); Beyersmann and Hartwig (2008).

<sup>17</sup> Change in ore use during 1941-1946 was due to World War II.

<sup>18</sup> Italian talc was still used in Shower to Shower after 1964.

<sup>19</sup> JNJTALC000425140.

<sup>20</sup> In 1963, Eastern Magnesia Talc Company developed a method allowing the production of cosmetic talc powder from Hammondsville mine in Vermont. IMERYS 238879. Eastern Magnesia Talc Company opened and operated the West Windsor Mill in 1964. IMERYS 077321. Johnson & Johnson purchased the West Windsor Mine in 1970. IMERYS 077321. Cyprus purchased Windsor Minerals from Johnson & Johnson, including West Windsor and Ludlow. IMERYS 077321.

- While the location for ore mined for Johnson's Baby Powder changed in 1964 to ore mined in Vermont, the ore utilized for Shower to Shower remained Italian until the mid-1970's.
- 1975- 1989: Hamm Mine, Vermont, Product Name: Grade 66 and Grade 96
- 1986-1990: Argonaut Mine and Hammondsville Mine, Vermont, Product Name: Grade 66.<sup>21</sup>
- 1989-1996: Hammondsville Mine, Argonaut Mine and Raindbow Mine, Vermont, Product Name: Grade 66 and Grade 96<sup>22</sup>
- 1996-2002: Argonaut Mine, Vermont, Product Name: Grade 66 and Grade 96<sup>23</sup>
- 2002-Present: Zhizhua Mine, Guigang Province, China,<sup>24</sup> Product Name: Guangxi #2 and Guangxi #2A

These mines are known to have impurities associated with talc, including toxic metals, chrysotile and amphibole asbestos (e.g., Van Gosen et al. 2004; Ross 1974; and example documents IMERYS 245144; IMERYS 467511; IMERYS-A\_0024548; JNJ 000521616; JNJAZ55\_000006341; JNJMX68\_000017827; WCD\_002478).

### *Mines in Italy*

Beginning in August 1926, Johnson & Johnson began purchasing ore from Italy. The Italian ore was named "E.G.T. Extra 00000." JNJAZ55\_000000049. Charles Mathieur & Co., Inc. supplied the talc from a mine in the Val Chisone region of Italy. JNJTALC000025882. Use of the Italian ore was eliminated, or significantly reduced, between 1941 and 1946, when talc was mined from California.<sup>25</sup> JNJAZ55\_000000049. However, after 1946, Johnson & Johnson again used 100% Italian talc in Johnson's Baby Powder.

In 1959, a Johnson & Johnson representative visited the mine in Val Chisone. At that time 85% of the high-grade talc came from the Fontane (fontana) mine. JNJ 000088048. At the mine, the ore was drilled, blasted and then selected as either white talc ore or gangus. It noted the "obvious gangus" included "brick-size blocks of dolomite, veins of fine-grained secondary calcite, the off-color gray-talc, occasional pyrite cubes (up to 1 inch in diameter), course green tremolite, and 'eggs' of rounded bodies of fine-grained quartz, carbonite, and probable chlorite." *Id.* Then the white ore "is thrown into a mine care designated for the picking shed." The process continues at the picking shed where "the white ore is picked of its obvious course gangus contaminants prior to its going into hoppers which supply a steady stream of trucks. "Run of mine" ("ROM") ore went to Johnson & Johnson. *Id.*

The ROM ore was designated into either grade 1 or grade 2. Grade 1 is primarily course chunks that are ground while grade 2 includes both chunks and fines:

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<sup>21</sup> IMERYS 077321.

<sup>22</sup> Breakdown of formula was 75% ore from the Hammondsville Mine, 15% ore from the Argonaut Mine, and 10% of the ore from Rainbow Mine. IMERYS 334779.

<sup>23</sup> IMERYS 117598.

<sup>24</sup> Mines are located in Longshen county, Zhizhua talc quarry (Guilin); Guping talc quarry (Longsheng). JNJI4T5\_000005147; IMERYS 061692.

<sup>25</sup> In February 1945, "the 100% Domestic Talc now used in Baby Powder formula, to be changed to 75% Domestic talc and 25% Italian talc." JNJTALC000025902

The logic in the operation appears to be that whereas the coarse contaminants have been removed at the picking shed at the mine, the contaminants which are in the fine particles are necessarily overlooked. Hence, milling primarily coarse ROM ore produces a slightly purer product (Grade 1), than does the milling of the whole ROM ore...both chunks and fines (Grade 2).

JNJ 000088048. The different grades are not decided based on “location in the deposit, but the result of selection at the mine face and picking shed.” *Id.*

Johnson & Johnson sourced talc from Italy until approximately 1964, when they switched and began using ore mined in Vermont. JNJTALC 000294523. While Italian talc was no longer used in Johnson’s Baby Powder, it was used in Shower to Shower. The talc, Italian talc 1615 AGIT, was ground at the Metropolitan Talc Company, located in South Plainfield, New Jersey.

Based on what I have reviewed, I have sufficient basis to conclude that Italian ore was of poor quality. These documents, reviewed below, show that Johnson & Johnson and Imerys were aware that Italian ore contained hazardous and dangerous carcinogens. There is no indication from the documents reviewed that Johnson & Johnson or Imerys attempted to ensure that the Italian ore was safe for use in cosmetic products. The documents reviewed span several decades, and are summarized as follows:

- JNJ000087868 – A Battelle Memorial Institute document dated Oct. 15, 1957 notes contaminants in the talc including trace amounts of amphiboles.
- JNJ000087231 – A Battelle Memorial Institute document dated 1958 indicated the presence of tremolite in the talc, commonly at levels ranging from 1-3%. That document also studied the abrasiveness and grit of Italian talc, noting:

Grit consists of that portion of ground talc which is angular, or oversize, particularly in thickness. Grit includes both oversize and nonplaty talc particles as well as mineral contaminants. It occurs as aggregates of talc and contaminants, as acicular and fibrous particles of talc and amphibole, as shards and granules of amphibole or carbonate, and as prismatic grains of titanite, rutile, zircon, apatite, and other accessory minerals.

The Italian [grade] No. 1 talc contains from less than 1 per cent to about 3 percent of contaminants. The contamination is natural and consists mostly of carbonate with minor amphibole and rare accessory minerals. ...The amphibole component has been established to be the variety tremolite.

- JNJAZ55\_000000213 – An undated geological report documenting minerals “associated with Val Chisone talc ore,” including tremolite, actinolite, calcite; magnesite; and quartz. “It is normal to expect the additional following elements to be entrained” in the above minerals, including lead; zinc; cobalt; barium; beryllium; tin and nickel. JNJAZ55\_000000213.
- JNJAZ55\_000006103 – An August 1971 document, authored by Bill Ashton, indicates that the mineralization in the Val Chisone valley includes “Talc, Pyrite,

Magnetite, Calcite, Dolomite, Apatite, Clinocllore, Chrysotile, Tormaline, Tremolite, Actinolite, Illemenite, and Albite.”

- JNZAZ55\_000000087 – A 1972 document published by Cardiff University found the presence of tremolite, serpentine and actinolite in the Val Chisone mine: “The Italian talc 00000 contains observable quantities of chlorite and carbonate minerals and could contain any one of the following minerals in very minor amounts: muscovite, quartz, tremolite, garnet and rutile.”<sup>26</sup>

### *Mines in Vermont*

The United States Geological Survey (“USGS”) provides basic background information on the quality of mines located in Vermont. Vermont mines are a part of the Appalachian Ultramafic Belt. (IMERYS 425354). This ultramafic belt extends the full length of the state, and has bodies of ore of Hazen Notch, Store, Ottauguechee and Missisquoi Formations of the Cambrian and Ordovician age. (Ratte, 1982). The common rocks in this ultramafic belt are enriched in nickel, chromium and cobalt.

The Argonaut mine(s), located in Ludlow, Windsor County Vermont,<sup>27</sup> was used for cosmetic talc. This mine was as an open pit talc mine in an ultramafic-hosted talc-magnesite deposit that first began production in 1972.

The Hamm Mine is located in North Windham, Windham County, Vermont, and includes open pit mines as well as quarries.<sup>28</sup> The Hamm Mine geology is comprised of talc, steatite and pods of serpentine (ultramafic rocks), a precursor mineral for asbestiform minerals. The mine is part of the Stowe Formation in the Missisquoi Formation from Late Ordovician. The Hamm Mine was mined for cosmetic talc. The Hamm mine was an open-pit mine.

The Hammondsville mine is also located in Windsor County, Vermont.<sup>29</sup> The mine is composed primarily of talc-soapstone, host ultramafic. Originally, the mining operation was underground, but it was converted to an open-pit mine.

The Rainbow Mine is located in Windsor County, Vermont. This mine contains steatite, talc and serpentine. The rock type is metamorphic, phyllite, from the Missisquoi Formation formed during the Late Ordovician. The Raindbow mine was a surface mines.<sup>30</sup>

### *Mines in China*

China produces almost half of the world’s supply of talc and is the world’s largest exporter of the mineral (IMERYS 034115). Imerys and Johnson & Johnson have purchased raw talc ore

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<sup>26</sup> A report, published in 1959, found that the Italian product “contained less than 1 per cent each of nonplaty (fibrous) talc, dolomite, and tremolite.” JNJ 00087166.

<sup>27</sup> United States Geological Survey, Argonaut Mine, [https://mrdata.usgs.gov/mrds/show-mrds.php?dep\\_id=10089897](https://mrdata.usgs.gov/mrds/show-mrds.php?dep_id=10089897) (last accessed Aug. 1, 2018).

<sup>28</sup> United States Geological Survey, Hamm Mine, [https://mrdata.usgs.gov/mrds/show-mrds.php?dep\\_id=10081775](https://mrdata.usgs.gov/mrds/show-mrds.php?dep_id=10081775) (last accessed Aug. 1, 2018).

<sup>29</sup> United States Geological Survey, Hammondsville Mine, [https://mrdata.usgs.gov/mrds/show-mrds.php?dep\\_id=10076176](https://mrdata.usgs.gov/mrds/show-mrds.php?dep_id=10076176) (last accessed Oct. 27, 2018).

<sup>30</sup> United States Geological Survey, Rainbow and Black Bear, [https://mrdata.usgs.gov/mrds/show-mrds.php?dep\\_id=10081671](https://mrdata.usgs.gov/mrds/show-mrds.php?dep_id=10081671) (last accessed Oct. 27, 2018).

from the Guangxi Province for their talcum powder products since 2003. Specifically, Grade 25 talc (Guangxi #2 and Gaungxi#2A) was produced from talc mined in the Guigang Zhizhou Quarry (IMERYS 030231; IMERYS 032139; IMERYS 034036). Specifically, mines were located in Longsheng county, Zhizhua talc quarry (Guilin); Guping talc quarry (Longhseng). JNJ14T5\_000005147; IMERYS 061692. The Guangxi Province ore is found in carbonate rock type, which is characterized by steatite talc with higher-grade talc and lower grade tremolite-carbonate talc types. Steatite is often associated with varying amount of amphiboles, typically tremolite and actinolite. Additionally, ore can also be composed of dolomite and quartz. *Id.*

As far back as 1983, Defendants had information indicating that Chinese talc contains higher than normal heavy metal contents, like lead, cobalt, chromium iron, nickel and titanium. *See* JNJ 000059273 (“The trace metal analyses indicate the lead content may rise to undesirable levels on an average mine basis at Guping Pit. It is expected that higher than normal heavy metal contents will be concentrated in the gray and green talc components.”).

In the Guangxi Province, talc is primarily concentrated in Longsheng, Shanglin, Baise, Luchuan and Huangjiang regions. IMERYS 413792. The Guangxi Province was first surveyed for talc production in the early 1960s. In 2003, these mines produced 557 kilotons of talc ore, and 259,6 kilotons of that ore was exported to other countries. *Id.* In “Talc Geology, Resources, Production and Market Study, Guangxi Autonomous Region”, asbestos was discovered in fractures of the talc ore body of the Maanshan Talc deposit located in the Shanglin region. IMERYS 413792. The asbestos fibers were 0.2-1 centimeters long and comprised less than one percent of the ore. *Id.*

Beginning in July of 2004, Rio Tinto began investigating talc operations and talc potential in the provinces of Hubei and Shandong. IMERYS 415991. Defendants were also looking at the continuing viability of Guangxi ore. Rio Tinto employees, including David Crouse, toured talc districts and reported their findings and impressions.

“Field Trip Report on the Talc Mining and Prospect Areas in Hubei, Guangxi and Shandong Provinces, China,” recorded David Crouse’s trip to Hubei Province and the “Xinshi” prospect. IMERYS 415991. The report claims, “most of the ore bodies produce sorted ore in excess of 90 Minolta whiteness,” however “[m]inor amounts of chlorite and dolomite are associated with the ore.” *Id.*

The report detailed a visit to Liboshikuang Mine in the Shandong Province. In that mine, the report noted that the overall balance of ore was 60% white talc and 40% black talc, with the latter having “obvious” tremolite association. IMERYS 415991. Notably, the Shandong Province was also associated with amphibole grade morphisms. Therefore, Johnson & Johnson and Imerys had information regarding tremolite’s presence in the region, and could be reasonably anticipated to be present in the ore used in talcum powder products.

Also of note is that for the Xinshi prospect area there is minor green flaky talc, collected from Tongzishan #1, Jhizua #1, Guping #1, and Dadi Camp. This is significant in that the green color indicates it likely has appreciable levels nickel and other toxic metals. Additionally, only eight samples were taken during the entire trip to China (IMERYS 416007), one of which was identified as containing intergrown bladed tremolite. Considering the trip was for basic assessment and that multiple properties and locations were visited, I would expect much more sampling – in

the range of 100 to 150 samples – to occur to give a crude assessment of quality. This lack of sampling suggests a general lack of rigor in assessment, economically and operationally. In the report’s conclusion, there is no mention of the need to screen or plan a protocol or procedure for the prevention of tremolite or other asbestos contamination (IMERYS 416007).

I reviewed multiple documents detailing the relationship between Rio Tinto and its progeny with the Chinese manufacturers responsible for its cosmetic talc ore. Defendants claim to have built a twenty-plus year relationship with the Chinese companies based off a desire to provide the highest quality ore product for its customers. IMERYS 173933. The practices and procedures Defendants tout fall short of satisfying international standards of quality and purity. Defendants depended almost entirely on the Chinese mining company to control the quality of the ore in the mine. In light of the anticipated harmful constituents (including asbestos), additional ongoing, on-site testing would have been necessary to ensure the purity of the ore, but this was not done. IMERYS 240978.<sup>31</sup>

Defendants were dependent on the Chinese manufacturer to first hand sort the talc to determine purity. The practice of hand sorting is not acceptable in the United States. For example, Kent Cutler<sup>32</sup> summarized the “testing” process performed on the ore before it leaves a Chinese port:

The lot to be shipped is inspected visually in the port stock yard before loading, during production or during loading by our internal expert (geologist, qualify in Mineralogy): are checked: cleanliness of the ore, the measures taken to prevent contamination, quality of the ore (whiteness, mineralogy), origin of the ore, handling, screening & loading conditions, cleanliness of the handling tools, storage conditions, status of the vessel, cleanliness of the hold where the talc is transported  
....

JNJI4T5\_000005147. Cutler goes on to say, “In principle, this inspection is enough to guarantee the requested specs and insure no fibers.” *Id.* That practice falls below the standards of quality control in mining operations in the United States, and it does not guarantee the absence of fibers, such as asbestos or fibrous talc.

A document entitled “Quality Control Procedures” for Guiling Guiguang Talc Development, provides another example of insufficient sampling methods for talc. JNJ 000414760. This document includes procedures related to Guangxi #2 and #2A, the talc ore purchased by Defendants for use in Johnson’s Baby Powder and Shower to Shower products. Again, the procedure calls for samples to be ground prior to testing a protocol that will disrupt the physical properties of the talc ore, making detection of harmful contaminants, including asbestos, much more difficult. If this method was used in sampling, it is likely that there were extensive false negatives for asbestos detection.

After leaving Chinese ports, the ore was shipped to Imerys’ Houston operations, the location where the ore was processed for Johnson & Johnson products.

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<sup>31</sup> Plaintiffs have requested test results from samples taken in the Chinese mine, but they have not been provided.

<sup>32</sup> Kent Cutler is Imerys’s Vice President of Sales and Marketing.



To date, the reviewed documents show that the vast majority of talc obtained by Defendants since at least the 2000s came from China. Evidence shows that Chinese ore contained harmful contaminants, including asbestos.

### **Standard Protocol for Analysis within Mine Operations**

The accepted practice in quality control of mine operations for minerals used in cosmetics is to do repeated analysis of materials, typically daily or weekly, to ensure quality and absence of harmful or toxic materials. Usually, companies have a dedicated in-house laboratory for these analyses, and will send samples (often replicates of the same in-house samples to assess variability) to third party laboratories as an additional quality check and to ensure in house results are accurate. (Jackson, Knaebel 1934; British Standard Institution, 1960). Methods of analytical evaluation of talc in mining operations have existed for decades, with advances in portable technology over the last ten to fifteen years making rapid onsite analysis of in-place ore, processed ore, and mineral product possible.

Each of the below methods are used for the analysis of industrial mineral ores for both mineral content and chemical content. The goal of the methods is to permit identification of high quality ore, discrimination and avoidance of low quality ore, and documentation of contaminants and impurities.

Below are descriptions of the analytical techniques described by Defendants:

*Transmission electron microscopy* (“TEM”) is an analytical method where sample material is investigated by an electron beam interacting with a small, typically three-millimeter sample. The technique is commonly used in geology for investigating mineral particles or rock samples, and can be used to identify asbestos. (e.g., USEPA Method EPA / 600/R-93/ 116, 1993; USEPA/540/2-90/005a, May 1990, USEPA Report No. 68-02-3266, 1984, NIOSH Manual of Analytical Method 1987).

*Scanning electron microscopy* (“SEM”) is an analytical method where sample material is investigated by an electron beam interacting with sample material. Images of the surface of the sample can be obtained as can chemical information for a given element. This technique can identify asbestos (e.g., USEPA Method EPA / 600/R-93/ 116, 1993).

*Polarized light microscopy* (“PLM”) is an analytical method where sample material is mounted on glass slides and investigated using a traditional light microscope where light may be polarized to induce color changes. This technique is used for identification of asbestos. (e.g., USEPA Method EPA / 600/R-93/ 116, 1993).

*Powder X-ray diffraction* (“XRD”) is an analytical technique where samples are first powdered or prepared as oriented slides. An X-ray beam interacts with the sample over a range of geometries, obtaining information regarding the sample’s mineral structure. Defendants have used this technique for identifying minerals and crystalline materials, as a part of the CTFA J4-1 testing protocol, although it is ineffective for this purpose.



### Evidence that Asbestos Occurred in Defendants Mines.

The documents I reviewed provide strong evidence that the talc used by Imerys and Johnson & Johnson to produce Johnson's Baby Powder and Shower to Shower came from mines that contained asbestos minerals, or fibrous talc in an asbestiform habit. (Ross, 1974; Van Gosen, et al., 2004; *see also* JNJMX68\_000017827; JNJAZ55\_000006341; WCD\_002478; IMERYS-A\_0024548; IMERYS 467511; JNJ 000521616; IMERYS 245144). In a 1992 document, JNJ 000297576, describing lab results from RJ Lee Group, fibrous talc is reported: "A small fraction of the talc in both samples is fibrous. As discussed early in this report, even if fibrous talc does not fall within the definition of asbestos, fibrous talc occurring in an asbestiform habit has the same dangerous carcinogenic properties as asbestos. (IARC, 2012). Therefore, the numerous examples showing presence of fibrous talc are of significant concern both from a human health and from a quality control standpoint. The following documents illustrate knowledge of the presence of asbestiform minerals and fibrous talc in asbestiform habit mined for cosmetic purposes.

I incorporate by reference Dr. William Longo and Dr. Mark Rigler's reports in subsection of "d" of my "Materials and Data Considered." Of note, Dr. Longo and Dr. Rigler found fibrous talc in 41 of the 42 talc samples reviewed in their November 2018 report.

### Presence of Asbestos in Defendants' Talc Ore:<sup>33</sup>

Date	Exhibit #/Bates No.	Testing Entity	Mine	What was tested	What tests revealed
10/15/1957	J&J-309	Battelle		Italian talc	"the Italian talc averages about 10% fibrous or acicular particles"
1/24/1958	J&J-310	Battelle		Italian talc	3 to 10% non-platy with trace amounts of tremolite
5/9/1958	J&J-1	Battelle	Val Chisone	Processed talc Italian 1	tremolite
5/9/1958	J&J-311	Battelle		Italian talc	"acicular and fibrous particles of talc;" the 8 to 10% of non-platy talc is presumed to be derived from tremolite or enstatite"
5/23/1958	J&J-2	Battelle	Val Chisone	processed talc- Italian 1	tremolite; 6 to 10 % fibrous talc
9/18/1961	J&J-313	Battelle		Hammondsville core	2 percent non platy talc in upper core; 14% (granular and fibrous ) non platy talc with 1-2% altered amphiboles in lower core

<sup>33</sup> For all of the charts presented herein, I reserve the right to supplement every one of them if relevant documents become available.

Date	Exhibit #/Bates No.	Testing Entity	Mine	What was tested	What tests revealed
12/4/1970	J&J-9	Colorado School of Mines	Hammondsville	38 core samples	tremolite-actinolite; fibrous talc
3/9/1971	J&J-257	McCrone		Shower to Shower; medicated powder	“fiber of chrysotile... Was very clear;” “medicated powder we found one fiber of chrysotile;” “Shower to Shower...we feel strongly that it may be chrysotile...chrysotile is very low;” >>> Final Report >>> “Shower to Shower The fiber content of Shower to Shower is quite low in comparison to previous samples which we have investigated...We found three suspect fibers . Of these, two were found in one field and probably have the same source, very possibly contamination...it is still questionable whether they are chrysotile. We have, however, found traces of chrysotile in G-11 one of the additives to Shower to Shower, and this might be a possible source of these contaminant fibers.”
5/14/1971	J&J-255	J&J		Baby Powder (production batch)	tremolite; tremolite-actinolite
7/2/1971	J&J-256	Colorado School of Mines		six monthly plant run samples	5 of 6 show tremolite-actinolite; “no other forms of non-talc minerals approaching asbestos types were identified”
7/7/1971	J&J-15	Colorado School of Mines	Vermont talc	processed talc-344-L	tremolite & actinolite

Date	Exhibit #/Bates No.	Testing Entity	Mine	What was tested	What tests revealed
7/29/1971	J&J-19	Colorado School of Mines, McCrone, Dartmouth	Vermont talc		“trace amounts of fibrous minerals;”  (tremolite/actinolite)
10/12/1971	J&J-23	McCrone		Shower to Shower	traces of chrysotile in one of additives
8/3/1972	J&J-28	NYU		Shower to Shower sample 84	5% chrysotile;
8/9/1972	J&J-342	J&J		Shower to Shower	“trace tremolite” in 1970 and 1971 samples
8/10/1972	J&J-373	J&J		Shower to Shower	“About 1 fiber or rod/needle every 500 particles. Approx. 1/3 of these are tremolite...”
8/24/1972	J&J-29	Sperry Rand		Shower to Shower	“asbestos fibers could be detected in the sample;” “reported chrysotile”
8/31/1972	J&J-348	Sperry Rand		Shower to Shower	Dr. Weissler used SEM “to study general shape of chrysotile asbestos.” “Dr. Weissler he did find fibers which had the general shape of chrysotile.” Also found “asbestos form fibers.” In samples brought by JJ which were photographed.
9/8/1972	D-7	Sperry Rand		Shower to Shower	Observation of asbestiform “more correctly be called fiber form.” SEM “very able to identify fiber forms which may be chrysotile”
9/26/1972	J&J-31	Dr. Lewin		J&J Medicated Powder; Johnson's Baby Powder; J&J Shower to Shower	Medicated Powder: tremolite 4% Baby Powder: 2-3% chrysotile Shower to Shower: 2-5% chrysotile
10/27/1972	J&J-36,34,37	McCrone		Johnson's Baby Powder batch # 108T & 109T (Lewin Samples)	“Both samples contained an insignificant amount of tremolite;”  tremolite rods

Date	Exhibit #/Bates No.	Testing Entity	Mine	What was tested	What tests revealed
10/27/1972	J&J-263	J&J		Johnson's Baby Powder batch # 108T & 109T (Lewin Samples)	"There are trace quantities [tremolite] present confirmed both by McCrone & Bill Ashton Levels are extremely low but occasionally can be seen optically. This is not new."
??/??/1972	J&J-33	University of Minnesota		Shower to Shower	"chrysotile asbestos does exist in the specimens of shower to shower"
2/26/1973	J&J-100	Colorado School of Mines		processed talc	tremolite-actinolite; slight trace of anthophyllite? Chrysotile? "asbestos type materials"
4/19/1973	J&J-296	J&J		Johnson's Baby Powder	"four of the samples are suspected of containing tremolite based on the finding of one or two 'fibers' per sample which satisfy the color/morphology criteria."
4/26/1973	J&J-44	J&J	Hammondsville	Johnson's Baby Powder	"tremolite or actinolite are identifiable (optical microscope) and these might be classified as asbestos fiber"
4/27/1973	J&J-335	J&J		Johnson's Baby Powder	"trace amounts of amphibole" in all 4 samples tested; "Shape-prismatic, columnar, parallel – sided rods;" Size: from 20X4 microns to 200X30 microns.; Identify: the optical properties of the particles are closer to actinolite than tremolite
5/1/1973	J&J-367		Hammondsville	ore	"the ore body contains tremolite"

Date	Exhibit #/Bates No.	Testing Entity	Mine	What was tested	What tests revealed
5/8/1973	J&J-368	J&J	Hammondsville	ore	“Your question this morning was how did Lewin assay timing relate to actinolite showings. Baby Powder lots 108T & 109T were alleged to contain asbestiforms by Lewin. Talc shipments checked by microscope have showed all lots clean just prior to and right after that time. the first showing of actinolite we know about is October 1972. The indications are that things were in good shape when Lewin picked up the above two lots for his assays.”
6/6/1973	J&J-47	Cardiff	Vermont	talc samples	actinolite
8/27/1973	J&J-299	Dutch consumer organization		Johnson's Baby Powder	“asbestos – content of 1.59%”
9/6/1973	J&J-258	FDA		Shower to Shower sample 84	“fibers of tremolite/actinolite”
12/21/1973	J&J-263	Colorado School of Mines	Vermont	talc samples	“identified chrysotile at a level of less than 10 ppm in the Vermont sample”
1/29/1974	J&J-57	McCrone; Dartmouth	Hammondsville	ore & product	“chrysotile fiber suppression was indicated;” Dartmouth finds amphibole 100 to 200 ppm in ore and 3000 in ore; McCrone finds chrysotile in ore and finished product
3/1/1974	J&J-58	Dartmouth	talc product & ore from Windsor	ore & product	“ore sample contains 2300ppm actinolite and the talc product contains 170 ppm actinolite;” “small amounts of anthophyllite may be present”

[illegible]

Date	Exhibit #/Bates No.	Testing Entity	Mine	What was tested	What tests revealed
10/19/1974	J&J-75	Cypress		talc samples	the “presence of asbestos mineral in both samples;” “tremolite was readily apparent ...possible chrysotile was also observed;” “the presence of tremolite form of asbestos”
7/1/1975	J&J-89	McCrone		“from your ore body”	“confirmed asbestos;” low to medium; “bundles of amphiboles”
9/9/1975	J&J-92	Mt. Sinai		Johnson's Baby Powder	anthophyllite & tremolite
9/11/1975	J&J-297	McCrone		A-HC	chrysotile fiber
11/5/1975	J&J-97	McCrone		ore	Table 1 lists “fibers of asbestos”
1975	IMERYS 210810	McCrone		Windsor Minerals samples	chrysotile
7/5/1976	J&J- 303	Colorado School of Mines		Johnson's Baby Powder	“small (1%?) amounts of amphibole needles.”
1/25/1977	J&J-141	Cardiff		Vermont composite sample	fibers of antigorite
6/14/1977	J&J -246	EMV		ore & product	composite samples-large and small fibrous tremolite
10/4/1977	IMERYS 210707	McCrone		40 talc samples	chrysotile in CI-J
10/5/1978	IMERYS 210707	McCrone		38 talc samples	chrysotile fiber in 2 samples
2/9/1979	J&J-164	George Lee's Group		66 composite samples	tremolite & actinolite
2/9/1979	J&J-341	J&J		Windsor 66 composite sample	“massive amphiboles in the 66 composite sample of Nov 6-10. The sample was forwarded to George Lee's group where the present of amphiboles was confirmed. They were identified as tremolite & actinolite”
9/8/1980	IMERYS 210707	McCrone		#TC-V	one fiber of chrysotile



Date	Exhibit #/Bates No.	Testing Entity	Mine	What was tested	What tests revealed
11/6/1980	J&J-169	McCrone		"talc sample"	chrysotile asbestos
9/1/1983	J&J-175	McCrone	Argonaut; Rainbow	air samples	Argonaut - 118 fibers; Rainbow- 2650 fibers
1/12/1984	J&J-305	McCrone		Talc powder, grade EV	"[S]ample contains 2 to 3% by weight tremolite-actinolite. The tremolite-actinolite in the sample is considered to be asbestos by current government regulations; however, it appeared to be cleavage fragments of the massive form rather than true asbestiform. Typical tremolite fibers from the sample are shown."
11/2/1984	J&J-179	McCrone		air samples	6,600 to 60,000 chrysotile asbestos fibers. All samples found asbestos
5/15/1985	J&J-177	MSHA	Italian talc	air samples at Cyprus South Plainfield	71.2% fibrous talc & "5.8% anthophyllite, an asbestiform amphibole"
8/22/1985	JNJMX68_ 000013019	McCrone	McCrone Project No. ME- 1862	Sample (WMI 85-28 & WMI 85-30)	Chrysotile asbestos
4/29/1986	J&J-182	McCrone		talc samples	chrysotile detected in all samples
8/5/1986	J&J-184	McCrone	Hammondsville	air samples	fibers in both samples
3/30/1987	J&J-185	J&J	Raymond Mill	Processed talc	"Tremolite is present in the fines (minus 100 plus 200 mesh) in six volume percent as free needles"
3/14/1988	JNJ 000062176	RJ Lee	J&J talc sample	Sample (879-57 Talc L)	.0024% chrysotile; .014% fibrous tremolite
4/15/1988	J&J-190	Skyline Laboratories; Aquatec Environmental	Chester/Hamm	random and composite process samples	Actinolite
1988	J&J 0144301			Vermont	Fibrous tremolite at 0.14%
5/23/1989	JNJNL61_ 000006792	RJ Lee	talcum powder	Sample (736- 116)	2 chrysotile fibers
7/31/1989	JNJ 000223449	RJ Lee	J&J talc sample	Sample (731-120)	3 chrysotile fibers

Date	Exhibit #/Bates No.	Testing Entity	Mine	What was tested	What tests revealed
11/19/1990	J&J-0007797		McCrone Cyprus Windsor Project	Sample (CWM 90-28)	1 chrysotile fiber
11/20/1990	J&J-0007801		McCrone Cyprus Windsor Project	Sample (CWM 90-29)	Antigorite
12/5/1990	JOJO-MA90013-0005		McCrone J&J talc sample	Sample (33-HV66)	One antigorite fiber
1990	J&J 000797			West Windsor sample (CWM 90-28)	Anthophyllite
1990	IMERYS 238478 IMERYS 238468 IMERYS 238457		Cyprus Windsor	Sample	Actinolite and tremolite in float feed and conditioner slurry
1/10/1991	IMERYS 211157	Dr. Blount	Blount Study	Baby Powder made from Vermont talc (Sample 1)	Tremolite needles and fibers
1991	J&J-327	Cypress	Argonaut mine		"Argonaut main ore body open pit ... high incidence of fibre bearing zones encountered in the main ore body"
2/25/1992	J&J-202	Cyprus	Argonaut; Hammondsville; Black Bear	ore	"[F]ibrous tremolite was identified...in exposures and cores at the east Argonaut 7 Black Bear mines. Cyprus staff report past tremolite from the Hammondsville and Clifton deposits."
3/25/1992	IMERYS 219720		Cyprus Ore reserves: arsenic and tremolite	Ore	Fibrous tremolite
7/2/1992	IMERYS 051370		Luzenac found amphibole in West Windsor	Float feed (CWM 92-12; 92-16)	<1% amphibole (actinolite and actinolite cleavage fragments)
1993	IMERYS 238270		Hamm	ore	Fibrous actinolite
7/15/1994	IMERYS 051442	Luzenac	West Windsor float feed and slurry	Float Feed	<.1% tremolite

Date	Exhibit #/Bates No.	Testing Entity	Mine	What was tested	What tests revealed
11/3/1994	IMERYYS 051436	Luzenac	West Windsor slurry	Slurry	<.1% amphibole (actinolite in the form of cleavage fragments)
2/8/1995	IMERYYS 442232	Luzenac	McCarthy found needles from Argonaut Ore	Ore	Needles
10/13/1995	JNJ 000063951	RJ Lee	talcum powder	Product (Sample A-1)	tremolite particle in Sample A-1
3/26/1996	JNJMX68_000004296		J&J V-96 talc	Talc product	Amphibole
4/2/2001	IMERYYS 189001	Luzenac	Argonaut Ore to West Windsor Mill	Ore	1 chrysotile fiber
1/1/2002	IMERYYS 130504	Imerys	Grade 96	Ore	Chrysotile (1 structure $\leq 5 \mu\text{m}$ )
6/1/2002	IMERYYS 130504	Imerys	Float Feed	Ore	Chrysotile (1 structure $\leq 5 \mu\text{m}$ )
9/1/2002	IMERYYS 130504	Imerys	Float Feed	Ore	Chrysotile (1 structure $\leq 5 \mu\text{m}$ )
10/1/2002	IMERYYS 130504	Imerys	Grade 96	Ore	Chrysotile (1 structure $\leq 5 \mu\text{m}$ )
2001-2002	IMERYYS 499486	Imerys	Drilling program	Drill core samples	Fibrous tremolite
2003	IMERYYS 499264	Imerys	Drilling program	Drill core samples	tremolite to 4% in 1998 Argonaut drill core
2/24/2004	JNJ 000375383	Forensic Analytical	TEM Analysis on behalf of KRCA in Sacramento, CA by Forensic Analytical	Baby Powder made in Vermont	0.2% Anthophyllite Asbestos

#### Presence of Fibrous Talc in Defendants' Ore:

Bates Number	Date	Location Found (Mine/Ore/Product)	Finding
JNJ 000085374, JNJNL61_000 00266	March 1945 Sept. 1945	Domestic/ Probably Vermont talc	Very course, fibrous talc Granular and Scaly - Aggregates of fibrous to scaly talc are apparent
JNJNL61_000 001341	5/23/1958	Italian ore and Italian floated ore	Italian No. 1 and Italian No. 2 (6% fibrous; 8-10% fibrous) (p 1350); Raw Italian No. 1 (9% fibrous) (p 1360), Raw Italian No. 2 (5% fibrous) (p 1360), Floated Italian No. 2 (3% fibrous) (p 1359)

Bates Number	Date	Location Found (Mine/Ore/Product)	Finding
JNJS71R_000 001978	12/4/1970	Hammondsville Mine	Drill hole 1-67--H: 10-20% fibrous talc (p 2016); Drill hole 6-67-H: 5-20% fibrous talc (p2017); Drill hole 21-67-H: <1% fibrous talc (p2018); Drill hole 35-67-H: 10-20% fibrous talc (p2019); Drill hole 36-67-H: 2-10% fibrous talc (p2020); Drill hole 38-67-H: 5-20% fibrous talc (p2022); Drill holes 39 thru 41-67-H: 5-12% fibrous talc (p2023-5); Drill holes 44 thru 45-67-H: 2-5% fibrous talc (p2026-7); Drill hole 46-68-H: 3% fibrous talc (p2028); Drill hole 49-68-H: 1% fibrous talc (p2029); Drill hole 50-68-H: 3% fibrous talc (p 2030); Drill hole 55-68-H: 5-10% fibrous talc (p2031)
JNJ 000234805	6/24/1971	Grantham, Italian & Vermont Talc Final Products	Talc Needles: 2.2%; 1.4%; 0.8%; 1.2%; 0.8%; 1.4%; 0.6%; 1.0%; 1.8%; 2.2% (p 4810); Talc Shards: 2.8%; 4.8%; 5.2%; 3.0%; 2.8%; 2.2%; 1.4%; 1.6%; 3.8%; 1.6% (p 4810); Talc Needles: 0.020%; 0.026%; 0.012%; 0.084%; 0.011%; 0.022%; 0.004%; 0.05%; 0.0295%; 0.03% (p 4812); Talc Shards: 0.41%; 0.617%; 0.944%; 0.42%; 0.404%; 0.283%; 0.792%; 0.15%; 0.7311%; 0.45% (p 4812)
JOJO- MA2330	8/19/1971	J&J Baby Powder	12 fibers seen in sample from batch 344L, all but one were identified as rolled or folded talc particles, the remaining wasn't positively identified, but it was suggested not asbestos (p 0034).
JNJNL61_000 024657 (letter); JNJNL61_000 024650; JNJNL61_000 032036	10/12/1971	Italian ore; Medicated Powder; Shower to Shower	Italian: Domestic ground Italian sample showed more fibrous talc than the Italian ground; Medicated powder: few examples of fibrous talc; S2S: talc patterns which appear as fibers
JNJNL61_000 033574	10/22/1971	"Sample 228-P"	3.6% "free talc needles"

Bates Number	Date	Location Found (Mine/Ore/Product)	Finding
JNJNL61_000 023234, JNJ 000229914	10/27/1971	J&J Baby Powder Product	A few fibrous talc particles
JNJNL61_000 024449	11/10/1971	"J & J baby talc" - Dr. Langer	"many fibrous talcs;" chrysotile
JNJ 000238826, JNJ 000248023	5/25/1972	FD-14 Tremolite Talc examined by McCrone	50% Fibrous Tremolite, 10% Antigorite, 35% talc of which about 75% is platy and 25% is rolled or fibrous, 2-5% Chlorite under one testing method, under another it was more like 60% Amphibole Tremolite, 15-20% platy talc, 20-30% fibrous talc and talc shards and 1% carbonate mineral. Looking at X-Ray Diffraction of FD-14 found 10% additional fibrous talc
JNJ 000314680	6/27/1972	NIOSH testing of 7 talcum powders	7 samples previously analyzed and diagnosed as having varying amounts of fibrous talc, J&J Medicated powder and Johnson's Baby Powder were both tested to see how many fibers a mother/baby would be exposed to. Medicated powder: mother: .06 fibers/field; baby: .05 fibers/field JBP -- Mother : .08 fibers/field; baby: .07 fibers/field Desitin - Mother: .17 fibers/field ;baby: .09 fibers/field
JNJNL61_000 025152	9/8/1972	Italian mine	Specimen I8: fibrous aggregates in the finer talc lenses (p 5166); Specimen I22: fibrous clusters of talc (p 5183); Specimen I24: fibrous aggregates within the main mass of talc (p 5183); Specimen I26: fibrous and feather aggregate of talc (p 5187); Specimen I45: talc ore containing randomly oriented "matted" aggregate of fibrous talc (p 5200)
JNJS71R_000 009825	4/26/1973	J&J Baby Powder	"Our Baby Powder contains talc fragments classifiable as fiber." "...no final product will ever be made which will be totally free from respirable particles."
JNJS71R_000 007083	9/19/1973	Vermont talc	Dr. Pooley reports Vermont talc contains about 1% fibrous talc
JNJS71R_ 000000139,  JNJ 000086280	9/28/1973	J&J Baby Powder Product; Italian Cosmetic Talc - Val Chisone	Fibrous talc particles in J&J BP and Val Chisone cosmetic talc, Dr. Pooley and Rolle discuss how fibrous talc may be misidentified as chrysotile

Bates Number	Date	Location Found (Mine/Ore/Product)	Finding
JNJ 000232897	5/6/1974	JNJ Samples and a Merck sample	JNJ sample 00C6-406 was mostly platy talc with some fibrous talc which morphologically looks like amphibole
JNJS71R_000 002199; JNJ 000246844	5/8/1974	W. Windsor ore and talc products	66-A-ore: fibrous or rod-shaped particles appear to be talc; 66-U-ore: fibrous forms that are talc rolls and shards; 66-U-product: talc ribbons and rolled talc...very few inorganic fibers. One fiber resembled chrysotile; 66-AC-ore: fibrous content consisted entirely of talc rolls and shards; 66-AC-product: fibrous talc content, rolled talc and talc fibrils, one chrysotile fiber
JNJ 000346572	7/17/1974	Johnson's Baby Powder Product	2 samples examined M & P - both samples found indications of carbon particles, Sample M also showed lots of talc fibers and rolled talc. Sample P showed 1 particle of Chrysotile, Rolled and fibrous talc in sample M noted again
JNJ 000222851	8/8/1974	Windsor minerals samples used primarily in roofing	One sample showed large blocky and fibrous talc particles, also showed small fiber of chrysotile
JNJ 000252742	8/8/1974	Windsor Minerals had McCrone test 6 samples of talc	Several samples showed chrysotile, sample C-GI 7-8-74 to 7-12-74 contains a relatively large amount of fibrous material
JNJS71R_000 011316	10/10/1974	Windsor 11 samples	One sample found to contain fibrous asbestiform material, other samples contained a large percentage of rolled talc, talc shards, and chunky material (probably chlorite) E-GI 7/29 to 8/12 talc shards and ribbons were present; many additional samples contain various fibrous talcs

Bates Number	Date	Location Found (Mine/Ore/Product)	Finding
JNJNL61_000 064162; JNJNL61_000 064161 (letter) [with sample key in JNJNL61_000 006591]	12/31/1974	W. Windsor mill ore and ore noted as “used in cosmetic”	“Most of the ‘fibrous’ material was talc in one form or another;” fibrous talc in W. Windsor ore and talc specifically for use in cosmetics
JNJNL61_000 043243 (letter); JNJNL61_000 043244; JNJNL61_000 043245; JNJNL61_000 043246 [with sample key in JNJNL61_000 006591];	7/1/1975	W. Windsor mill ore and ore noted as “used in cosmetic”	Indications of blocky talc and rolled talc Fibers rolled talc silicates: noted low and medium in HC (cosmetic) talc and WI (Windsor) talc; “silicate fibers;” “fibrous talc;” and “talc fiber” listed in HC and WI talc
JNJNL61_000 027053	7/29/1975	W. Windsor ore	Some fibrous talc present
JNJ 000065666	2/18/1976	Italian ore and Italian floated ore	2 samples contained talc ribbons, small rolled fibers of talc and talc chards; all fibrous type talc
IMERYS 210824	4/26/1976	W. Windsor mill ore “industrial grade” and ore noted as “used in cosmetic”	21 samples were tested with some chrysotile and antigorite found as well as some fibrous F2-LI 11/24 to 12/8/1975: Platy talc with some talc fibers E2-LI 11/3 to 11/24/1975: Very platy, a few talc fibers H2-LI 12/22/75 to 1/5/75: Some platy, some talc fibers, some blocky K2-HC 1/26 to 2/13/76 - Play, few shards
JNJ 000346747	6/2/1976	Johnson & Johnson Baby Powder talc	Sample 2 found some rolled talc and talc ribbons, Sample 3 contained some fibrous talc but most of the sample consisted of platy talc Sample 4 was mainly platy talc, but found some talc ribbons Sample 6 showed some very fine talc ribbons Sample 7 showed some small fibers all of which were talc



Bates Number	Date	Location Found (Mine/Ore/Product)	Finding
IMERYS 210700	8/31/1976	Vermont 66 Talc	Higher Chlorite levels than normal found - current levels estimated at 1-3%
IMERYS 210701	10/11/1976	Vermont 66 Talc	Higher Chlorite levels continued
JNJNL61_000 043271 (letter); JNJNL61_000 043272 [with sample key in JNJNL61_000 006591]	12/2/1976	W. Windsor mill ore and ore noted as "used in cosmetic"	Talc ribbons and fibers; talc fibers; fibrous talc
JNJ 000314406	2/22/1977	Italian "Val Chisone" Samples determination of fibers	Total fibers in Ray 3 - 82,000 fibers/g in Ray 4-5/0 Total fibers were 79,000/mg
IMERYS 210810-210812	10/4/1977	W. Windsor mill ore and ore noted as "used in cosmetic"	40 talc samples tested some showed ribbons or fibers HC-M 4/4/77 to 4/16/77 - Fine ribbons some antigorite CI-R 3/14/77 to 3/21/77 - some shards present CI-X 4/25/77 to 5/2/77 - Some shards and ribbons CI-B 10/25/76 to 11/1/76 - Fibers and ribbons present CI-N 2/16/77 to 2/21/77 - Fine talc ribbons and shards
IMERYS 210801-210803	10/5/1978	W. Windsor mill ore and ore noted as "used in cosmetic"	38 talc samples analyzed; some small chrysotile fibers found as well as some ribbons, shards, and fibrous talc. Aa 10/17 to 10/28 1977: Some rolled talc and talc shards. Ba 11/15 to 12/12/ 1977: Rolled talc and talc shards with some talc ribbons. Ea 1/3 to 1/13 1978: Only mineral "fibers" observed are talc rolls and shards. CA 12/5 to 12/16 1977: No mineral fibers other than talc shards and rolls. Fa 1/16 to 1/27 1978: Only material that appears fibrous is talc -- rolls and shards principally with one or two ribbons. Ga 1/30 to 2/11/1978: Some substantial talc needles. Ia 2/27 to 3/10/1978: Several ribbons and shards present
IMERYS 210794 A166	12/20/1979	Windsor mill ore and ore noted as "used in cosmetic"	18 samples submitted under R-2612; Most of the samples had a few talc "ribbons" which were confirmed by selected area electron diffraction

Bates Number	Date	Location Found (Mine/Ore/Product)	Finding
IMERYYS 210788- 210799	3/27/1980	Windsor mill ore and ore noted as “used in cosmetic”	Almost all of the samples consisted principally of very platy talc with probably fewer than average ribbons, shards or pseudo-fibrous particles.
IMERYYS 210758	9/8/1980	W. Windsor mill ore and ore noted as “used in cosmetic”	19 Talc samples submitted, one sample TC-V had one fiber of chrysotile present
IMERYYS 210724	7/21/1983	W. Windsor mill ore and ore noted as “used in cosmetic”	7 monthly composite samples submitted all showed a fibrous clay (sepiolite) at small percentages
JNJ 000281919 (letter); JNJ 000281921	9/3/1992	Bulk samples	TEM from RJ Lee: 2 samples with small amount of fibrous talc
IMERYYS 477879	5/8/1999	Grade 66 Q1 composite silo sample	Talc A99062: several fibrous structures displayed electron diffraction patterns indicative of talc (p 883)
JNJ 000260807	Undated	Examination of J&J Italian talcs	Samples of Italian talc, one ground in Italy and one ground domestically were tested, fiber content of Italian ground talc less than 0.001% most of which is rolled talc, some fine fibers were also found, Domestic ground talc contained more fibrous talc than Italian Ground
JNJ 000269904	Undated	Final report on STS, Medicated Powder and Feminine Spray	Feminine spray had a few examples of rolled talc or other fibers, a few talc fibers were identified with electron diffraction Medicated Powder: Few examples of fibrous talc and one fiber which could be considered suspect Shower-to-Shower: Fiber content quite low but showed rolled talc at 0.001% to 0.005% - 3 suspect fibers, a few talc shards were also found

Defendants own testing results from the 1960s through the 2000s make clear that the Vermont mines contain asbestos (e.g., JNJ 000238035, JNJ 000223449, IMERYYS 418940, IMERYYS 238270). In fact, “Tremolite and actinolite are ubiquitous in several zones of the Vermont Mines. The potential problems involved with fibre in dumps and to some degree in products, must be carefully evaluated.” IMERYYS 4253584.

There is evidence that chrysotile and tremolite existed commonly in the Italian and Vermont mines in the early 1970’s. In a 1973 report of a Cosmetic, Toiletry, and Fragrance Association (“CTFA”) Talc Subcommittee on Methods, a round robin testing program of talc samples both from the United States and abroad found high percentages of asbestos fibers present

in the samples. Several companies participated, including Johnson & Johnson, and the vast majority discovered asbestos fibers in the samples investigated. WCD000001.

A 1972 Cardiff University report, cited in a previous section, reported the presence of tremolite, actinolite and serpentine in Italian Mine Val Chisone samples. The removal of tremolite asbestos at the Italian Mine site was done solely by the sorting of single hand sized rocks, an inadequate technique for properly and safely removing asbestos from ore during the selection process.

Another document, from March 1992, documents the presence of asbestos and Defendants' knowledge thereof: "The other serious mineralogical contaminant in the talc ores of Vermont is the fibrous variety of the amphibole minerals, tremolite and actinolite." IMERYS 418940. That document goes on to say: "Vermont talcs are derived from altered serpentine – a natural host for asbestiform minerals. There is certainly visible tremolite and actinolite in specific zones of the Vermont deposits. Fibrous tremolite was identified in exposures and cores at the East Argonaut. West Windsor (beneficiation) staff report past tremolite from the Hammondsville and Clifton deposits."

Another document, IMERYS 219720, chronicles an interoffice correspondence data from March 25, 1992, from R.C. Munro, showing there is clear evidence that asbestos occurred in the Argonaut, and West Windsor operations:

"[T]he other serious mineralogical contaminant in the talc ores of Vermont is the fibrous variety of the amphibole minerals tremolite and actinolite (hydrous calcium iron-magnesium silicates)..."

and

"Vermont talcs are derived from altered serpentine – a natural host for asbestiform minerals. There is certainly visible tremolite and actinolite in specific zones of the Vermont deposits – fibrous tremolite was identified by the writer in exposures and cores at the East Argonaut and Black Bear Mines."

and

"[A] recent paper published by Rutgers University worker, Alice Blount, suggests the presence of fibre in several cosmetic talcs, some of which might have been from the Cyprus West Windsor material, which is a source of great concern to Cyprus management and potentially to their principal customer Johnson & Johnson. Talc de Luzenac personnel are well aware of the situation and Phillpe Moreau is currently quietly working to identify the reality and the magnitude of the problem."

and

"Cyprus staff report past tremolite from Hammondsville and Clifton deposits."

In an April 1992 document involving core from the Hamm mine, multiple impurities in the talc ore should have called into question, for a responsible mining company, the overall quality of the ore. These impurities included abundant bladed actinolite zones associated with

chlorite/hornblende/biotite schist and talc schist (IMERYYS 435988), fibrous tremolite (IMERYYS 435992), and amphibole at 2-3% and fibrous actinolite (IMERYYS 436000). These findings indicates that the talc is intimately associated with asbestiform minerals and the association was easy to recognize in these deposits.

In a May 1992 interoffice correspondence regarding the Hamm Mine core drilling, there is indication that fibrous amphiboles (actinolite) extended, in places, inches into the contacting talc ore (IMERYYS 238270). More alarming, at the end of that document the writer notes “talc ore observed to contain fibrous amphibole was not included in a sample interval.” So not only is Defendant aware of the presence of potentially carcinogenic material in the ore, they are ignoring contaminated ore for purposes of sampling.

In a 1999 Windsor talc document, IMERYYS 213431, there is evidence that the reported cosmetic talc has an X-ray diffraction peak for serpentine. The composite report for those samples reported serpentine at 0.9% and 0.4%. A hand-written note on page three of this document indicates that there were three hits for serpentine for Silo 5 and four hits for serpentine for Silo 2 and “wwff does not look great.” The remainder of the note refers to urgently calling several individuals in the morning.

IMERYYS 422289, dated May 23, 2002, reports polarized light microscopy results and scanning electron microscopy results of mine waste material containing asbestos from the Argonaut mine, located in Vermont. Although PLM data is not shown, as is typical of these reports, the SEM data shows significant amounts of tremolite fibers, substantiated by an energy dispersive X-ray spectrum from the sample. This is a significant finding for several reasons. This data indicates that asbestiform tremolite was in the Argonaut mine. Although the exact provenance or exact spatial location of the waste material remains undisclosed, the nature of the blasting, ore excavation and ore removal process in an open-pit setting make it more likely than not that tremolite was mixed with the talc ore. Furthermore, this likelihood of tremolite (or other asbestiform materials) remaining in or contaminating ore product by simple exposure to the open air in the mine with normal wind, precipitation and cross contamination by hauling equipment, loading equipment and worker interaction is high.

Later in the 2000s, evidence exists from coring and field investigations that there was knowledge of asbestos and mineral crushed or ground into asbestiform minerals. For example, Cyprus staff report past tremolite from the Hammondsville deposit (IMERYYS 418940). Fibrous tremolite was identified in exposures and cores at East Argonaut. *Id.*

In summary, the reviewed documents have established the presence of asbestos in the talc mined and manufactured for Johnson’s Baby Powder and Shower to Shower. Defendants admit that the beneficiation process does not remove asbestos. Patrick Downey Dep. 407: 13-16 (Aug. 8, 2018). Therefore, it is very likely that these asbestos continued to be present in the final product.

### **Toxic metal contamination**

As discussed above, talc often is associated with or contains arsenic, and heavy metals such as cadmium, cobalt, chromium, lead, and nickel. Documentation notes their presence in ores used to produce talcum powder products: IMERYYS 304036; IMERYYS 342524; JNJ 000237076; JNJ 000247375; JNJ 000246467; and IMERYYS 094601. In fact, these chemical elements are inherent

properties of talc ore, a fact acknowledged by Julie Pier in her deposition. Julie Pier Dep. 211: 6-13 (Sept. 12, 2018).

Bates Number	Date	Description	What Was Tested	What Was Revealed
JNJ 000087928	10/1/1972	Baby powder	J&J 228P	Cobalt: 50 ppm Chromium: 190 ppm Nickel: 1500 ppm
JNJ 000237379	12/31/1975	Ore & Concentrate	Stun A	Nickel: 1900 ppm/2500 ppm
JNJ 000238011	9/30/1976	Baby powder	Formula 34 Formula 499 Formula 499	Cobalt: 57 ppm, N/A, 50 ppm Chromium: 185 ppm, N/A, 190 ppm Nickel: 1500 ppm, 1480 ppm, 1500 ppm
JNJ 000088570	2/12/1981	Omya Talc C-1 and Canada 1980 WTS *Analysis sent to J&J	3 Samples	Cobalt: 84.4 ppm, 63.6 ppm, 73.8 ppm Chromium: 194 ppm, 214 ppm, 305 ppm Nickel: 2560 ppm, 2650 ppm, 2090 ppm
JNJ 000285351	12/19/1988	talcum powder	Sample (879-162)	Cobalt: 84 ppm Chromium: 262 ppm Nickel: 2560 ppm
JNJ 000246437	2/7/1990	talcum powder	Sample (90-53)	Cobalt: 83 ppm Chromium: 426 ppm Nickel: 940 ppm
JNJ 000237076	10/1/1991	talcum powder	Samples (28005 & 28006)	Cobalt: 56 ppm/57 ppm Chromium: 277 ppm/251 ppm Nickel: 1720 ppm/1942 ppm
JNJ 000239723	6/1/1992	talcum powder	Sample (39-HV66)	Cobalt: 63 ppm Chromium: 328 ppm Nickel: 2100 ppm
JNJ 000239730	3/10/1994	talcum powder	Sample (93-HV66)	Cobalt: 67 ppm Chromium: 457 ppm Nickel: 2260 ppm
JNJ 000063608	3/13/1995	talcum powder	Sample (94-V66)	Chromium: 569 ppm Cobalt: 60 ppm Nickel: 2070 ppm
JNJ 000291914	7/16/1997	Grade 66	1996 Annual Composite Sample	Cobalt: 8.1 ppm Chromium: 25.4 ppm Nickel: 247 ppm
IMERYS 342524	9/22/1997	Grade 66	Annual Composite Sample	BPT 148 v. ICP Cobalt: 8.1 ppm v. 92 ppm Chromium: 25.4 ppm v. 273 ppm Nickel: 247 ppm v. 2490 ppm
JNJ 000291916	3/9/1998	Grade 66	1997 Annual Composite Sample	Cobalt: 77.9 ppm Chromium: 255 ppm Nickel: 2060 ppm
JNJ 000347962	5/11/1998	Windsor 66	Non-Shear Disc Talc Sample	Cobalt: 79.3 ppm Chromium: 110 ppm Nickel: 2190 ppm
JNJ 000347962	9/24/1998	Windsor 66	Non-Shear Disc Talc Sample	Cobalt: 67.8 ppm Chromium: 85.8 ppm Nickel: 2020 ppm
JNJ 000347962	9/25/1998	Windsor 66	Non-Shear Disc Talc Sample	Cobalt: 67.4 ppm Chromium: 92.5 ppm Nickel: 2020 ppm
JNJ 000886067	2/9/1999	Grace 66	1998 Annual Composite Sample	Cobalt: 72.9 ppm Chromium: 275 ppm Nickel 2080 ppm
IMERYS- A_0015663	10/7/1999	Grade 66	5 Non-Shear Disc Talc Samples	Cobalt: 67.4-82.9 ppm Chromium: 85.8 -169 ppm Nickel: 1810-2190 ppm

Bates Number	Date	Description	What Was Tested	What Was Revealed
IMERYS 045184	2/21/2000	Grace 66	1999 Annual Composite Sample	Cobalt: 81.9 ppm Chromium: 136 ppm Nickel: 2180 ppm
IMERYS 045182	7/28/2000	Grade 66	3 Ore Samples	Cobalt: 76.8-77.3 ppm Chromium: 199-324 ppm Nickel: 1890-2000 ppm
IMERYS 304036	9/26/2000	Grade 66	3 Non-Shear Disc Samples	Cobalt: 79 – 89 ppm Chromium: 230-288 ppm Nickel: 2410-2510 ppm
IMERYS 053387	2/21/2001	Grade 66	Composite Sample (A01055-1)	Cobalt: 79.3 ppm Chromium: 110 ppm Nickel: 2190 ppm
IMERYS 340454	2/7/2002	Grade 66	1999 Annual Composite Sample	Cobalt: 79.6 ppm Chromium: 223 ppm Nickel 2260 ppm
IMERYS 340798	3/10/2003	Grade 96	2002 Annual Composite Sample	Cobalt: 71.3 ppm Chromium: 245 ppm Nickel: 1980 ppm
IMERYS 286445	1/5/2004	Grade 96	2003 Annual Composite Sample	Cobalt: 77.3 ppm Chromium: 284 ppm Nickel 2100 ppm

#### *Arsenic*

Arsenic contamination in the talc ore mined by Defendants is well documented. Arsenic is a known human carcinogen. (IARC, 2012). This is particularly true for ore mined in Vermont, including Ludlow, West Windsor, Argonaut and Hamm. The following documents provide examples or records recoding arsenic levels well above international and national health standard regulations.

- IMERYS 418940 – A 1992 inter-office correspondence indicating that generally the Ludlow Rainbow deposit arsenic concentrations were less than 100 parts per million (“ppm”), but small zones existed where arsenic concentrations was greater than 1000 parts per million (or greater than a tenth of a percent), numbers above the 3 parts per million guidelines of the CTFA. (Fiume et al., 2015). The document also indicates the presence of arsenic has been present in mill feed at West Windsor from at least 1987 to the time of the document in 1992.
- IMERYS 425354 – A February 1992 memo by Munro, noted “Arsenic Minerals, both insoluble sulphides and the more soluble arsenate minerals are problems that restrict productivity in an effort to keep product under 3 ppm soluble As [arsenic] in the West Windsor and Johnson Mills. High arsenic restricts product acceptance and lays a basis for future possible environmental and permitting problems.” Also, “[t]he Hamm mine has established problems with high arsenic zones and areas with fibrous actinolite, but is mined for it relatively high talc content and high brightness ores.”
- IMERYS 219720 – A March 1992 document indicating the presence of high arsenic in the ore from samples taken from the Ludlow Rainbow deposit. Notably, the document states that arsenopyrite – a major and common form of arsenic, and its alterations products, which are highly likely to contain arsenic, are present in many of the talc-carbonate schist ore zones in the Vermont area. On average, for the Ludlow Rainbow deposit, arsenic averaged less than 100 ppm, but small zones existed in excess of 1000 parts per million prior to processing (or ~0.1 weight percent).



- IMERYYS 048393 – A document from October 1992 of the Hamm and Ludlow mines shows that arsenic is present in at least 10s of parts per million commonly and up to 181 ppm for the Ludlow Rainbow Deposit.
- IMERYYS 304036 – A document from September 2000, where testing of three samples of Johnson & Johnson talcum powder indicated the concentrations of arsenic at 10, 11, and 19 ppm, all three exceeding the guideline for arsenic concentration in talcum powder products.<sup>34</sup> (Fiume, et al., 2015).

The above set of documents, from different decades and authors establish the presence of high levels of arsenic at the mines located in Vermont, mines from which Johnson & Johnson and Imerys mined talc ore for cosmetic talc products. National agencies have determined that arsenic is unsafe at levels above 3 ppm. (21 CFR §73.1550 (1984)). Defendants’ documents consistently show that the ore registered at levels well above 3 ppm.

### *Nickel*

Nickel is a known human carcinogen. (EPA, 2000; ATSDR, 2005). Both Johnson & Johnson and Imerys, established 10ppm as the acceptable limit for the presence of nickel in the talc ore. There is sufficient evidence to conclude that the talc mined for Johnson & Johnson’s baby powder and Shower to Shower products contained excessive levels of nickel, both by federal standards as well as standards established by Defendants. Defendants had information that mines producing talc for cosmetic purposes, including baby powder, contained high levels of nickel. An Imerys document IMERYYS 068482 titled “Typical Elemental Analysis Product: Vermont Products” recorded the nickel average as 1685 ppm. Evidence of high levels of nickel in the Argonaut mine are found in IMERYYS 430826; IMERYYS 430850; IMERYYS 430856; IMERYYS 430862; IMERYYS 430892; IMERYYS 474851.

The following is a chart documenting examples of excessive levels of nickel contained in Defendants’ post-processing talc ore:

Bates Number	Date	Description	What Was Tested	Nickel
JNJ 000087928	10/1/1972	Baby powder	J&J 228P	1500 ppm
JNJ 000237379	12/31/1975	Ore & Concentrate	Stun A	1900 ppm/2500 ppm
JNJ 000238011	9/30/1976	Baby powder	Formula 34 Formula 499 Formula 499	1500 ppm, 1480 ppm, 1500 ppm
JNJ 000088570	2/12/1981	Omya Talc C-1 and Canada 1980 WTS	3 Samples *Analysis sent to J&J	2090 ppm, 2560 ppm, 2650 ppm
JNJ 000285351	12/19/1988	talcum powder	Sample (879-162)	2560 ppm
JN J000246437	2/7/1990	talcum powder	Sample (90-53)	1940 ppm

<sup>34</sup> 21 CFR 73.1550 (1984).



Bates Number	Date	Description	What Was Tested	What Was Revealed
JNJ 000237076	10/1/1991	talcum powder	Samples No. (28005 & 28006)	1720 ppm/1942 ppm
JNJ 000239723	6/1/1992	talcum powder	Sample (39-HV66)	2100 ppm
JNJ 000239730	3/10/1994	talcum powder	Sample (93-HV66)	2260 ppm
JNJ 000063608	3/13/1995	talcum powder	Sample (94-V66)	2070 ppm
JNJ 000291914	7/16/1997	Grade 66	1996 Annual Composite Sample	247 ppm
IMERYS 342524	9/22/1997	Grade 66	Annual Composite Sample	BPT 148 v. ICP 247 ppm v. 2490 ppm
JNJ 000291916	3/9/1998	Grade 66	1997 Annual Composite Sample	2060 ppm
JNJ 000347962	5/11/1998	Windsor 66	Non-Shear Disc Talc Sample	2190 ppm
JNJ 000347962	9/24/1998	Windsor 66	Non-Shear Disc Talc Sample	2020 ppm
JNJ 000347962	9/25/1998	Windsor 66	Non-Shear Disc Talc Sample	2020 ppm
JNJ 000886067	2/9/1999	Grace 66	1998 Annual Composite Sample	2080 ppm
IMERYS-A_0015663	10/7/1999	Grade 66	5 Non-Shear Disc Talc Sample	1810-2190 ppm
IMERYS 045184	2/21/2000	Grace 66	1999 Annual Composite Sample	2180 ppm
IMERYS 045182	7/28/2000	Grade 66	3 Ore Samples	1890-2000 ppm
IMERYS 304036	9/26/2000	Grade 66	3 Non-Shear Disc Samples	2410-2510 ppm
IMERYS 053387	2/21/2001	Grade 66	Composite Sample (A01055-1)	2190 ppm
IMERYS 340454	2/7/2002	Grade 66	1999 Annual Composite Sample	2260 ppm
IMERYS 340798	3/10/2003	Grade 96	2002 Annual Composite Sample	1980 ppm
IMERYS 286445	1/5/2004	Grade 96	2003 Annual Composite Sample	2100 ppm

The test demonstrate show that post-processing talc in the talcum powder products contained high levels of nickel, a known carcinogen. The presence of nickel at high levels is consistent with the talc deposits at Vermont.

*Chromium*

Chromium can occur in two forms, Chromium III and Chromium VI. Chromium VI is a known human carcinogen. (ATDSR, 2012). The EPA, NIOSH and OSHA have established maximum safe levels for human consumption. (EPA, 1998; NIOSH, 2016; OSHA, 2012).<sup>35</sup> Based on what I have seen, it was a sufficient basis for me to conclude that the talc mined for Johnson & Johnson's baby powder and Shower to Shower products contained excessive levels of chromium, both by federal standards as well as standards established by Defendants. (EPA, 1998; NIOSH, 2016; OSHA, 2012) In fact, an Imerys document IMERYS 068482 titled "Typical Elemental Analysis Product: Vermont Products" recorded the "typical" chromium level to be 1700 ppm. IMERYS 120012 provides further evidence that Defendants were aware of the presence of chromium in talc. Evidence of high levels of chromium in the Argonaut mine can be found in IMERYS 430826; IMERYS 430850; IMERYS 430856; IMERYS 430862; IMERYS 430892; IMERYS 474851. No routine testing was done to determine the ratio of Chromium III to Chromium VI.

The following is a chart documenting examples of excessive levels of chromium in Defendants' post-processing talc ore:

Bates Number	Date	Description	What Was Tested	Chromium
JNJ 000087928	Oct-72	Baby powder	J&J 228P	190 ppm
JNJ 000238011	9/30/1976	Baby powder	Formula 34 Formula 499 Formula 499	185 ppm, N/A, 190 ppm
JNJ 000088570	2/12/1981	Omya Talc C-1 and Canada 1980 WTS *Analysis sent to J&J	3 Samples	Chromium: 194 ppm, 214 ppm, 305 ppm
JNJ 000285351	12/19/1988	talcum powder	Sample (879-162)	262 ppm
JNJ 000246437	2/7/1990	talcum powder	Sample (90-53)	426 ppm
JNJ 000237076	10/1/1991	talcum powder	Samples No. 28005 & 28006	277 ppm/251 ppm
JNJ 000239723	6/1/1992	talcum powder	Sample (39-HV66)	328 ppm
JNJ 000239730	3/10/1994	talcum powder	Sample (93-HV66)	457 ppm
JNJ 000063608	3/13/1995	talcum powder	Sample (94-V66)	569 ppm
JNJ 000291914	7/16/1997	Grade 66	1996 Annual Composite Sample	25.4 ppm
IMERYS 342524	9/22/1997	Grade 66	Annual Composite Sample	BPT 148 v. ICP 25.4 ppm v. 273 ppm

<sup>35</sup> OSHA established a 2.5 µg/m<sup>3</sup> exposure limit for Chromium VI, calculated as an 8-hour time-weighted average ("TWA") for airborne exposure. 1910.1026(b). NIOSH established a 1 µg Cr(VI)/m<sup>3</sup>, calculated at a 10-hour TWA. For public water systems, the EPA has established an exposure limit of 100 µg/L (100 ppb).

Bates Number	Date	Description	What Was Tested	What Was Revealed
JNJ 000291916	3/9/1998	Grade 66	1997 Annual Composite Sample	255 ppm
JNJ 000347962	5/11/1998	Windsor 66	Non-Shear Disc Talc Sample	110 ppm
JNJ 000347962	9/24/1998	Windsor 66	Non-Shear Disc Talc Sample	85.8 ppm
JNJ 000347962	9/25/1998	Windsor 66"	Non-Shear Disc Talc Sample	92.5 ppm
JNJ 000886067	2/9/1999	Grace 66	1998 Annual Composite Sample	275 ppm
IMERYS-A_0015663	10/7/1999	Grade 66	5 Non-Shear Disc Talc Samples	85.8 -169 ppm
IMERYS 045184	2/21/2000	Grace 66	1999 Annual Composite Sample	136 ppm
IMERYS 045182	7/28/2000	Grade 66	3 Ore Samples	199-324 ppm
IMERYS 304036	9/26/2000	Grade 66	3 Non-Shear Disc Samples	230-288 ppm
IMERYS 053387	2/21/2001	Grade 66	Composite Sample (A01055-1)	110 ppm
IMERYS 340454	2/7/2002	Grade 66	1999 Annual Composite Sample	223 ppm
IMERYS 340798	3/10/2003	Grade 96	2002 Annual Composite Sample	245 ppm
IMERYS 286445	1/5/2004	Grade 96	2003 Annual Composite Sample	284 ppm

JNJTALC000440312 indicates that chromium is present in talc: "Samples did not meet specification in the Chromium levels, which is very concerning. Samples did not meet standard on the simple difference in house test as well. Supplier was contacted has limitations to work on improvements, since chromium is found in the talc ore."

The observation of such high concentrations of chromium was consistent over time given the geology of the Vermont deposits.

### *Cobalt*

Cobalt is a Group 2B carcinogen, or an element that is recognized as possibly carcinogenic to humans. (ATSDR, CDC 2011). Johnson & Johnson established 10 ppm as the acceptable limit for the presence of cobalt in the talc ore. There is sufficient evidence to conclude that the talc mines for Johnson & Johnson's baby powder and Shower to Shower products contained excessive levels of cobalt, both by federal standards as well as standards established by Defendants. (NIOSH, 1994; OSHA, 1989). Defendants' test results demonstrate that the mines producing talc for cosmetic purposes, including baby powder, contained high levels of cobalt. Evidence of high levels of cobalt in the Argonaut mine can be found in IMERYS 430826; IMERYS 430850; IMERYS 430856,

IMERYS 430862; IMERYS 430892; IMERYS 474851; IMERYS 481989; IMERYS 481874; IMERYS 475372; IMERYS 475275.

The following is a chart documenting examples of excessive levels of cobalt in Defendants' post-processing talc ore:

Bates Number	Date	Description	What Was Tested	Cobalt
JNJ 000087928	10/1/1972	Baby powder	J&J 228P	50 ppm
JNJ 000238011	9/30/1976	Baby powder	Formula 34 Formula 499 Formula 499	57 ppm, N/A, 50 ppm
JNJ 000088570	2/12/1981	Omya Talc C-1 and Canada 1980 WTS *Analysis sent to J&J	3 Samples	84.4 ppm, 63.6 ppm, 73.8 ppm
JNJ 000285351	12/19/1988	talcum powder	Sample (879-162)	84 ppm
JNJ 000246437	2/7/1990	talcum powder	Sample (90-53)	83 ppm
JNJ 000237076	10/1/1991	talcum powder	Samples Nos. 28005 & 28006	56 ppm/57 ppm
JNJ 000239723	6/1/1992	talcum powder	Sample (39-HV66)	63 ppm
JNJ 000239730	3/10/1994	talcum powder	Sample (93-HV66)	67 ppm
JNJ 000063608	3/13/1995	talcum powder	Sample (94-V66)	60 ppm
JNJ 000291914	7/16/1997	Grade 66	1996 Annual Composite Sample	8.1 ppm
IMERYS 342524	9/22/1997	Grade 66	Annual Composite Sample	"BPT 148 v. ICP 8.1 ppm v. 92 ppm "
JNJ 000291916	3/9/1998	Grade 66	1997 Annual Composite Sample	77.9 ppm
JNJ 000347962	5/11/1998	Windsor 66	Non-Shear Disc Talc Sample	79.3 ppm
JNJ 000347962	9/24/1998	Windsor 66	Non-Shear Disc Talc Sample	67.8 ppm
JNJ 000347962	9/25/1998	Windsor 66	Non-Shear Disc Talc Sample	67.4 ppm
JNJ 000886067	2/9/1999	Grace 66	1998 Annual Composite Sample	72.9 ppm
IMERYS-A_0015663	10/7/1999	Grade 66	5 Non-Shear Disc Talc Samples	67.4-82.9 ppm
IMERYS 045184	2/21/2000	Grace 66	1999 Annual Composite Sample	81.9 ppm
IMERYS 045182	7/28/2000	Grade 66	3 Ore Samples	76.8-77.3 ppm
IMERYS 304036	9/26/2000	Grade 66	3 Non-Shear Disc Samples	79 – 89 ppm
IMERYS 053387	2/21/2001	Grade 66	Composite Sample (A01055-1)	79.3 ppm
IMERYS 340454	2/7/2002	Grade 66	1999 Annual Composite Sample	79.6 ppm
IMERYS 340798	3/10/2003	Grade 96	2002 Annual Composite Sample	71.3 ppm
IMERYS 286445	1/5/2004	Grade 96	2003 Annual Composite Sample	77.3 ppm

The observation of such high concentrations of cobalt was consistent with the geology of the Vermont talc deposits.

### **Examples of poor geologic investigations and control of ore body variability**

Based upon my expertise and knowledge of proper mining and sampling techniques for field testing ore, and the documents I have reviewed, Johnson & Johnson and Imerys failed to adequately sample and test the mines they utilized for cosmetic grade talc ore production. The adequacy of sampling and testing for cosmetic grade ore falls far below generally accepted best standards and common industry practices for this type of ore, given the nature of the finished products.

Examination of data from several mines shows the ore bodies as very complex, with mixtures of several rock types, including those likely to have the presence of asbestos and heavy metals. These rock types are intimately mixed with talc ore. The variation of the bodies of rock differs and significant features may be only one- foot thick or less.<sup>36</sup> Typically, when mining companies deal with complex ore bodies that could contain asbestos or asbestiform habit minerals, they would take reasonable precautions to exclude this material in the product production stream. These precautions would include developing mine maps from drill cores and core logs, and employing progressive mapping techniques like 3-D maps, which are developed to guide the mining process. The spacing of the cores in Imerys's Vermont drill program range from 100 to 500 feet, making a detailed assessment of the variation of the rock types for precise quality control purposes nearly impossible.

IMERYS 426677, IMERYS 427423 and IMERYS 427428 provide an example of insufficient ore sampling of the Argonaut mines. These documents relate to cores, or holes, R-98-1 through R-98-9. With the exception of core R-98-5 which was a vertical hole, all of these cores were obtained at an angle of 40 to 45 degrees and had lengths that varied from 83 feet to 383 feet. Using the map from IMERYS 426681, and the associated scale and core locations, an assessment can be made of core density. Of the approximate 5.28 acres available to be cored, Imerys only conducted coring on 2.18 acres or 41.3%.<sup>37</sup> This is below common industry practices, which based on the available data, in my opinion, should be drilling at a core density of 50 to 100 feet on a specific square grid pattern covering the entire ore body. Additionally, the location of drilling appears random, an atypical method for mining companies, who typically chose set distances to ensure that sample quality reflect available ore.

These documents also expose evidence of quality control gaps in data, including variations in the physical characteristics of the mined rocks, otherwise known as the rock's lithology. IMERYS 427429 provides no depth for Core R-98-2, and in IMERYS 426685 there are conflicting lithology given for Core R-98-9. The documents offer no justification for these discrepancies, suggesting an insufficient sampling process, poor review process, or both. These quality control gaps are concerning because an area of high contamination could be missed if a region of the

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<sup>36</sup> This is substantiated by a larger general body of work on the geology of talc mines (e.g., Furcron and Teague, 1947; Berg, 1977; Sandrone and Zucchetti, 1988; Van Gosen et al., 2004).

<sup>37</sup> Gy and others summarize and mathematically and statistically explain approaches for sampling mine materials spanning from 1895 until the late 1970s (e.g., Gy, (1979); Brunton, (1895); Demond and Halferdahl, (1922); Cochran, (1953); British Standard Institution, (1960); Becker (1964-1966); David, (1970); Armstrong-Smith, (1974)), and numerous papers by Gy from the early 1950s through the mid-1970s.

geology is poorly defined. Despite inadequate sampling and testing of ore deposits, detectable asbestos was found.

Another quality control issue apparent after studying the documents is the spacing and dimensions of core samples in the Vermont mines. Overall, the lithologies in the core data show a highly variable distribution. For example, in IMERYYS 426685, there are several units of talc and chlorite. Many of those cores units are approximately only one-foot thick, compared to the larger talc body that is over 120-feet thick in some locations. Given the diverse thickness of the ore body, it would have been necessary to take consistent core samples to accurately categorize the mineralogical features of the area. However, in this case, the erratic spacing of cores only captures one dimensional or very limited views, of the mineralogically diverse and complex ore body from which information must be extrapolated to form a 3-D model.<sup>38</sup> Examination of coring in documents shows Defendants failed to sample cores at sufficient density to characterize the complex ore bodies.

From IMERYYS 426681, approximately fifty feet of core length from R-98-2 and R-98-4 are within approximately fifty feet of each other. Similarly, Core R-98-2 and R-98-6 terminate within approximately seventy feet of each other. All other cores are approximately 100 feet or greater from each other. Given the scale of the observed lithologies in the core, which range from one foot to over 120-feet in a single dimension, the coring scheme undertaken in this example could not have effectively described this part of the mine in a scientifically reasonable manner. This is extremely problematic given the company's knowledge that the mines contained a multitude of mineralogical features, some of which are hazardous to human health, and commingled within the mined talc ore. The better alternative for mining companies is to core at a much higher density, simply avoid ore that is problematic, and explore better resources or different minerals to mine.

Additionally, in IMERYYS 426681, there is no other data associated with this report, thus, there is no interpretation of the geology or a geologic map or cross sections produced from the core data. Such data or interpretations are typically included in reports to provide detailed constraints on the geology to: (1) provide detailed operational planning; (2) provide a record for comparison for future work; and (3) provide quantitative data for concurrent or later in house and third party ore assessment. The data is limited for such use but there are some features defined by cross section and analysis of the geologic data. Based upon the above and my expert knowledge, this data was not interpreted in a meaningful way.

In 1978, additional drilling<sup>39</sup> was done in the Hammondsville mine to further define the ore body. IMERYYS 436972. Previous drill holes were at excessive distances (nearly 500 feet), and two were wrongly plotted and lie off the northern limit of the property, *see* IMERYYS 436979-80. This report also indicates that drilling was done in 1976 and 1977, however, the corresponding

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<sup>38</sup> Data from Imerys's 3-D model has been requested, but not provided. I reserve the right to supplement or amend my report when this information is received.

<sup>39</sup> Core samples should be collected and stored. A 1934 report by Jackson and Knaebel (1934) states: "[s]amples of core and cuttings should be filed in core boxes, drawers, or other suitable containers . . . "[c]ore should always be inspected carefully by a competent man at the time of drilling, but especially is this true when all core is assayed." I have requested the opportunity to inspect the drill cores in Imerys's possession, but it is my understanding that Imerys has rejected this request. If the cores are made available to me in the future, I reserve the right to supplement or amend my report.



core logs were not found, *see* IMERYS 436976. The inconsistent distances of drill holes is problematic for properly sampling an ore body because it fails to adequately account for the variations present in talc ore reserves. This is particularly true for Hammondsville, where documents show that Defendants were aware of the variable quality of ore present in the mine. Under similar circumstances, a mining company observing standard industry practices would core at a much higher density to better define the ore body and identify the best ore.

### **Specific Failures to Properly Sample Materials – Composite sampling**

As discussed below, Imerys failed to use an appropriate sampling method for the assessment of the mineralogical and chemical composition of the ore. Mining companies testing ore of this nature for contaminants and hazardous chemicals utilize both discrete and composite sampling, performing both at the same time. Afewu and Lewis (1998). Composite sampling is the process where a collection of numerous individual samples, called discrete samples, are combined. Composite sampling makes possible the ability to seemingly “pass” contaminated ore as meeting product specifications. Discrete mining allows for the identification of constituents at the exact source in the mine so it can be avoided in current and future mining, preventing contamination of operations and, if needed, recall lots of contaminated mineral product. Without discrete sampling there is very little control or understanding of where contaminated ore originated. Composite sampling, rather than discrete sampling or individual sampling, is used extensively throughout documents. The following documents are representative examples of composite sampling: IMERYS 136928, IMERYS 045194, IMERYS 045199, IMERYS 225111, IMERYS 189001, IMERYS 229069, IMERYS 046877, IMERYS 069210, and IMERYS 093711.

Composite sampling methods remain largely undefined within the documents. It is important that composite sampling be conducted in a consistent manner so that the samples taken over time may be accurately compared. Representative sample sets for a given area or region of the mine are necessary for mine planning. Examples of insufficient composite sampling methods can be found in IMERYS 069210<sup>40</sup> and IMERYS 093711. USP testing was completed on composite samples taken from every fifth truck, a fact acknowledged by Donald Hicks in his deposition. Donald Hicks Dep. 415: 23-24; 416:1-22 (June 29, 2018). A composite sample composed of material from every fifth truck would not be representative. Thus, the vast majority of ore from an untold number of lots remains untested, making it impossible to assess the mineralogical characteristics of the ore. It is reasonable to assume that ore of mixed quality, including ore contaminated with harmful constituents, would come into contact with the higher quality ore. IMERYS 093711 noted that Intertek found that:

[S]amples for the incoming raw material are taken from the large rocks and are not representative for the incoming raw material lot. A large rock from the shipment is milled and made into composites for USP/EP/FCC testing. A more representative sampling would be to take not only [one] large rock but smaller rocks from different parts of the shipment and create a composite sample for testing.

Composite sampling is a flawed methodology to adequately monitor for asbestos and toxic metals and should be reserved for products not intended for human consumption or cosmetic

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<sup>40</sup> IMERYS 069210 exemplifies how the traceability of any lot of talc ore is impossible, because the ore is transported by dump truck and stored in a large warehouse.



use. (Afewu and Lewis (1998). Asbestos and toxic metals do not occur uniformly in the ore, and the reviewed documents show a piecemeal sampling process that would not have captured the existence of asbestos and toxic metals. Blended ore would significantly mask the presence of asbestos and toxic metals, making detection even more difficult. Blended ore would also make results of subsequent analysis artificially low for constituents. Blending additionally makes traceability from product to lot to origin in the mine impossible.

It is my opinion to a reasonable degree of scientific certainty that Defendants' sampling methodology was insufficient to accurately and reliably detect asbestos and toxic metal constituents throughout the whole of the talc ore.

### **Specific Failures to Properly Analyze Minerals**

Based on my review of documents, Imerys Defendants (or labs they commissioned to test samples) failed to use the appropriate methodology for sample preparation and failed to properly execute necessary analytical methods to adequately determine the presence of potentially harmful minerals in the talc mined for cosmetic use. I observed additional examples of omissions and improper analytical techniques in the reviewed documents. The omissions and improper analytical techniques cover a wide variety of issues, including an absence of information in sample preparation, and incorrect methodologies for phyllosilicate sample testing. (e.g., JNJ 000270659, IMERYYS 048393). The Defendants' use of these techniques falls below or deviates from common industry practice, like the methods outlined in Bish and Reynolds, 1989.

A major issue facing workers attempting to analyze phyllosilicate samples with powder X-ray diffraction is that the method requires *crushing* – which is defined as an up and down motion in a mortar and pestle. Crushing is critical early in the sample preparation process to ensure that a solid sample, rather than an unconsolidated sample such as a soil, is obtained. The mechanical action of crushing is far less likely to “smear” the crystal structure. Smearing the crystal structure of phyllosilicates leads to weak diffraction patterns or patterns that are nearly or functionally amorphous. This is problematic because the more poorly crystalline a material is, the less pronounced the diffraction pattern is, making the detection of contaminants difficult or impossible (Bish and Reynolds, 1989). If a material is amorphous it may have a very weak or no diffraction pattern at all. Thus, if samples are not properly “crushed”, phyllosilicates such as talc, chlorite, and chrysotile can be under-detected or undetected in powder X-ray diffraction analyses.

Another issue facing workers is *grinding* – which is defined as a circular motion that fragments the crystal structures of phyllosilicates. Grinding disrupts the crystal structures of phyllosilicates because the weaker hydrogen bonds are broken and disorder between layers increases. The net effect is that the layers (e.g., the 2:1 layers in talc or micas) become disordered as the bonds holding these portions of the crystal structure are weakened. Imerys admitted, in deposition, that a phyllosilicate sample could be ground to a near amorphous state, damaging the sample even with minimal grinding. Julie Pier Dep. 25: 23-25; 26:1-23 (Sept. 13, 2018). Grinding samples to an amorphous state can degrade or destroy the crystal structure of phyllosilicates (e.g., Bloch, 1950; Čičel and Kranz, 1981; Cornejo and Hermosin, 1988; Dreif and Nieto, 1999; Gregg et al., 1953; Mackenzie and Milne, 1953; Miller and Oulton, 1970; Papirer and Roland, 1981; Pérez-Rodríguez et al., 1988; Reynolds and Bish, 2002; Suquet, 1989; Takahashi, 1959). The destruction of the sample by grinding prevents accurate detection of minerals within the sample.

*Example of questionable sample use and sample preparation in bulk chemical analysis.*

My review of the documents revealed Imerys analyzed a “composite” sample yearly. IMERYS-A\_0015621. It is unclear what is contained in the composite, and why a composite is only analyzed once annually. The singular annual composite does not meet with commonly accepted industry practices. This is particularly true, given that in 2015, Defendants estimated year-to-date on talc ore was estimated at 4,010 dry metric tons. IMERYS 195291. This is heightened by the fact that it is also an undefined composite material – the components are not known such as percentages or materials added, what and how they are mixed remain unknown as well. As noted above, in this report the use of composite sampling can suppress negative findings by mixing ore or product of lesser quality with ore or mineral product that is more contaminated or highly contaminated. As mentioned above, composite sampling makes possible the ability to seemingly “pass” contaminated ore as meeting product specifications. This Report notes that all of the metals detected in IMERYS-A\_0015621 were higher by approximately an order of a magnitude using inductively coupled plasma mass spectrometry (ICP-MS) conducted by CHEMEX labs, compared to Johnson & Johnson Method BPT 148. The difference between the findings is problematic and indicate that one or both methods are not accurate. The report does not indicate what was done to the tested product.

There is substantial evidence that Defendants systematically failed to utilize commonly accepted sampling practices and procedures for determining the presence of harmful contaminants and the overall safety of the ore.

### **Comments on Rejection and Failure Rate**

In mining and manufacturing, a *rejection rate* is the percentage of processed parts or product(s) that is not accepted for further production use or sale. This may be done over a fixed period of time or specified by a statistically meaningful number of pieces or analyses. Because industrial minerals are natural geologic materials, they always have impurities and those impurities can end up in the product stream at a number of points, like ore extraction, transportation, or processing.

*Failure rate* is the percentage of mineral product that does not meet customer specifications. As industrial minerals are natural materials with natural variability in properties, some failure rate is expected for all ore processed. Failure rate in industrial mineral product may arise from the presence of impurities, improper processing imposing a defective quality such as the wrong grain size, contamination of non-mineral materials, equipment failure or other processes.

Defendants lacked a standard rejection rate for both the ore mined, as well as for the materials that are manufactured and produced for cosmetic purposes. Such rejection rates would be defined by approaches as outlined in Gy, 1979. This absence is significant, as it implies that no cosmetic mineral product was ever rejected for failure to meet asbestos or heavy metal specifications. There is no mention of rejection of cosmetic talc for the presence of asbestos, fibrous talc or heavy metals. I observed that there are some numbers that indicate rejection rate or waste to product to ore ratio, but these numbers are not consistent across any of Imerys’ mines. IMERYS 425354. An important implication of the comparatively high rejection or waste ratios is

the subsequent ample opportunity for contamination of ore by waste exposed within or in proximity to the mine. Therefore, it is scientifically reasonable that some contamination from wastes in the mines made it into the ore and ultimately in the resulting cosmetic mineral product.

*Failure rates vary amongst ores and cosmetic mineral products but must occur at some level*

In all engineered systems there is a product failure rate or rejection rate that occurs (e.g., Finkelstein, 2008) and the reduction of this failure rate is one of the primary goals of reliability engineering. Product failure or rejection occurs when existing specifications are unmet or an error occurs in production that is unexpected, like the introduction of contaminants. Product rejection ultimately originates from several factors, including but not limited to: human error; entropy of the manufacturing system; and the nature of thermodynamics in general. With the three exceptions noted above, there is ***no indication of a rejection or failure rate that is reported for cosmetic talc***. This is highly unusual and unrealistic to have product that is defect free for decades.

### **Comments on Third Party Audits and Feasibility of an Internal Inspection Program**

Reviewed documents indicate Defendants lacked an internal systemic inspection program. Johnson & Johnson commissioned audits periodically for third party vendors. The third party audits exposed substandard management and analysis of talc materials.

#### *Third Party Audits*

In an August 9, 2009, letter from Intertek, Johnson & Johnson's third party auditor, informed Rio Tinto: "Based on Audit findings the Rio Tinto Minerals facility in Houston TX has been given a site rating of Marginal." JNJTALC000068407. Intertek was brought to the Houston facility to verify, "that adequate quality systems are in place to ensure the quality of materials supplied to Johnson & Johnson Consumer Companies Inc."

The audit identified issues as either "major" "marginal" or "critical." An observation was defined as "major" when either of the following conditions applied: "[a]ny non-conformance or non-compliance that if allowed to continue, has a moderate risk of adversely affective product quality;" and/or "[t]he observation represents the significant gaps and/or gaps in application of one or more quality system elements or system components necessary to meet regulatory requirements. This includes systematic lack of documented evidence of the application of the key elements."

Intertek identified seven major issues:

1. "Samples for the Incoming Raw Material are taken from Large Rocks and are not representative for the Incoming Raw Material lot."
2. "Retain samples are maintained for 1 year after manufacture. The GMPs require samples to be retained for 3 years from date of manufacture or 1 year after date of expiry, which ever is longer."
3. "No validation was performed for the RTM sharepoint System. The system is used as a repository and to control electronic copies of procedures. The system should be validated for intended use, including electronic approvals."

4. “The batches have no traceability from raw materials (based on one ship load) to shipping.”

Additionally, concerning “Minor” findings included that quality control samples were not logged in when they were delivered to the laboratory and out of specification quality control results were investigated by the same technician who received the out of specification result, rather than the initiation of a formal investigation.

These audit findings collectively show that Defendants did not performing representative sampling, leaving open the probability in light of the geology of the talc sources that s. Additionally, the findings show Defendants were mismanaging data and not curating materials properly, creating a disconnect between test result and sample origin and making traceability to ore lots and final product impossible. The audit makes clear that there are multiple failures indicating the Houston facility was not performing at a level consistent with standard industry practices.

#### *Proposed Program*

Based on the totality of the documents I have reviewed, the evidence reveals that the companies failed to inspect their talc products adequately. For example, and based off Johnson & Johnson’s 2014 production of 4000 metric tons of baby powder. IMERYS 033627. A minimal inspection rate of 1% of the industrial product would equate to approximately 40 metric tons of baby powder to be sampled over a year. A reasonable sample protocol would be to take sample sets from each mine used for cosmetic talc production each day or in the worst case at least each week for testing for harmful constituent minerals. Using the commonly accepted practice that thirty samples is a minimal statistically meaningful population for a sample set, taking thirty samples daily for an estimated 250 work days per year equals roughly 7,500 samples, *per mine or source*. Even if a lesser quality weekly sampling program was utilized using 30 sample sets for each sampling event, a total of 1560 samples would be available per year *per mine or source*. The documents I reviewed showed no systematic sampling program that would near these sampling numbers. Sampling appears to have been conducted at a sampling density that is not statistically meaningful and that is very irregular compared to industry norms.

#### **Summary of Opinions**

I have concluded to a reasonable degree of scientific certainty, the following:

1. The presence of asbestos and fibrous talc was and is present in the mines Defendants’ used for cosmetic talc;
2. The Defendants’ sampling was inadequate to be representative;
3. The irregularity of mine formation and presence of associated constituents made mining of pure talc impossible using methodology employed by Defendants;
4. The spacing of core drilling and the necessary extrapolation by mapping tools resulted in inaccuracies in the data for mine planning; and
5. There is significant evidence of toxic metals in post-processed ore used for Defendants’ talcum powder products.

I reserve the right to supplement my opinion should additional information be received.

# EXHIBIT

# A

**Dr. Mark P. S. Krekeler, 2083 Wagonwheel Drive, Hamilton, Ohio 45013  
513-907-7878 / krekelp@miamioh.edu**

## **Positions**

2014 – Present Associate Professor (tenured) Department of Geology & Environmental Earth Science, Miami University, Hamilton, Ohio [tenure beginning July 1, 2014]

2008- 2014 Assistant Professor (tenure-track) Department of Geology & Environmental Earth Science, Miami University, Hamilton, Ohio

2004 - 2008 Assistant Professor (tenure-track) Department of Environmental Science and Policy/Geology Program, George Mason University, Fairfax, Virginia

## **Education**

2003 Ph.D., Geotechnical Engineering and Earth Sciences, University of Illinois at Chicago, Chicago, Illinois (Dr. Steven Guggenheim, Advisor)

1998 M.S., Geology, University of Cincinnati, Cincinnati, Ohio (Dr. Warren Huff, Advisor)

1995 B.S., Geology, University of Cincinnati, Cincinnati, Ohio

## **Major Funding (2004-present)**

2018 \$333,703 from NSF – GEOPATHS- AUGITE career development

2016 \$547,722 from NIJ for remote sensing of human materials in the environment (start: 6/1/16)

2015 \$3,192 (NSF) ACACIA: Ancient Climate and the Authigenic Clay Index of Aridity. (Col. Prop.)

2014 \$3,192 (NSF) ACACIA: Ancient Climate and the Authigenic Clay Index of Aridity. (Col. Prop.)

2014 \$17,000 Internal grant for research assistantship - CFR

2013 \$92,000 (U.S. Army) Instrumentation acquisition with Dr. Catherine Almquist and three others.

2012 \$30,000 (Proctor & Gamble) Investigations of Novel Materials Produced from Battery Waste

2011 \$93,000 (Proctor & Gamble) Development of High Value Cryptomelane Materials from Batteries



2011 \$20,000 (Internal grant) Shoupp Award – Miami University  
2010 \$35, 211 (Internal grant) Research Incentive Grant –Miami University OARS office  
2010 \$5000 (Internal grant) CELTUA grant for Department of Geology & Environmental Earth Science  
2009 \$7300 (Proctor & Gamble) for battery recycling from Duracell  
2009 \$5,000 Internal grant for coal pollution in Hamilton, OH – Miami Hamilton Campus  
2008 \$17,000 Internal grant for research assistantship - CFR  
2008 \$30,000 Start-up funds from Miami University-Hamilton (over 3 years)  
2006-07 \$50,000 Investigation of clay resources in Polk County, Florida, awarded by Clear Springs, Inc.  
2006 \$50,000 Investigation of geomaterials for patents and development, provided by F Corporation  
2004-05 \$50,000 Start-up funds from George Mason University

### **Awards**

2018 Miami University Assigned Research Appointment Fall 2018  
2017 Miami University's Excellence in Career Development Award  
2012 Hamilton Campus Research Award  
2011 Miami University Assigned research Appointment Fall 2011

### **Training from the Collaborative Institutional Training Initiative (ID= 3999872)**

Humans as Subjects IRB Basic Course (2/1/2017; 2/7/2014)  
Emergency and Incident Response to Biohazard Spills and Releases (3/19/18)  
Initial Biosafety Training (3/19/18)  
OSHA Bloodborne Pathogens (3/19/18)

### **Additional Training**

Responsible Conduct of Research training (4/26/16)  
SANS Cybersecurity Training (6/1/18)  
Title IX training (8/21/17)  
Clery Act training (12/16/16)  
Regionals campus advisor training (5/16/16)

**Peer-Reviewed Publications** (\*denotes Miami undergraduate student, \*\*denotes Miami graduate student co-authors; †denotes article published before arrival at Miami University. ‡ indicates and article accepted without comment.). Journal quality is based on impact factors (IF) listed in the ISI Journal Citation Reports and current and five year impact factor (IF) are provided when available. Effort of contribution is listed. **Web of Science Citations are 380, h-index = 11 and Google Scholar Citations are 631, h-index = 14.**

\*\*Dietrich, M., \*Huling, J., Krekeler, M.P.S. (accepted) Metal Pollution Investigation of Goldman Park, Middletown Ohio: Evidence for Steel and Coal Pollution in a High Child Use Setting. *Science of the Total Environment*. (IF:4.900/5.102) Contribution 35%.

\*\*Burke M. Rakovan, J., Krekeler M.P.S. (in press) A study by electron microscopy of gold and associated minerals from Round Mountain, Nevada. *Ore Geology Reviews* (IF:3.095/3.449) dx.doi.org/10.1016/j.oregeorev.2017.08.026. Contribution 30%.

\*\*Cymes, B.A., Krekeler M.P.S., Nicholson K.N., Grigsby, J.D. (2017) A transmission electron microscopy (TEM) study of silver nanoparticles associated with mine waste from New Caledonian nickel deposits: potential origins of silver toxicity in a World Heritage Site. *Environmental Earth Sciences* Vol 76: 640. (IF:1.569/1.844) DOI 10.1007/s12665-017-6978-x. Contribution 25%.

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from northern Breathitt county, Kentucky. *Southeastern Geology* 51: 109-119. (IF: 0.176) Contribution 50%.

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## **Presentations n= 142 (\*Miami undergraduate student; \*\*Miami graduate students**

Krekeler, M.P.S., Burke, M., Allen, C.S., Sather, B., \*Dawson, C., \*Roberts, J. (2017) Progress in developing a hyperspectral remote sensing library and software tool for finding persons in the



environment. Abstracts and Program of the Annual Meeting of the Geological Society of America. Paper 327-15

\*\*Cymes, B.A., Krekeler, M.P.S., Almquist, C.B. (2017) The catalytic activity of natural cavansite ( $\text{Ca}(\text{VO})\text{Si}_4\text{O}_{10} \cdot 4\text{H}_2\text{O}$ ). Abstracts and Program of the Annual Meeting of the Geological Society of America. Paper 267-10.

Krekeler M.P.S., \*\*Dietrich, M., Vangala, S., Tully, J., LeGalley, E., Argyilan, E.P., Burke, M., Wolfe, A. (2017) Environmental properties and impacts of nanoparticles in urban landscapes of the Midwest: Microscopy studies of street sediment demonstrate cause for concern. Abstracts and Program of the Annual Meeting of the Geological Society of America. Paper 69-36.

Vangala, S., Bandi, M.R., Krekeler, M.P.S. (2017) Nitrate contamination in groundwater in some rural areas of Anantapur District, A.P. India. Abstracts and Program of the Annual Meeting of the Geological Society of [America. Paper 69-30.

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Fifer, C. R., Burke, M., Nicholson, K.N., Krekeler, M.P.S. (2017) Reflective spectral analysis of garnierites as a method of identifying possible nickel ore deposits through remote sensing techniques. Abstracts and Program of the Annual Meeting of the Geological Society of America. Paper 65-15.

\*Brum, J., \*Schlegel, C., \*Hernandez-Muniz, W., \*Dawson, C., Burke, M., Krekeler, M.P.S. (2017) Laboratory reflective spectroscopy investigations of heavy fuels, plastics and geomaterials for hyperspectral remote sending based environmental monitoring. Abstracts and Program of the Annual Meeting of the Geological Society of America. Paper 372-9.

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\*Lary, E., \*\*Cymes, B.A., Krekeler, M.P.S. (2017) Scanning transmission electron microscopy – energy dispersive spectroscopy (STEM-EDS) reveals compositional heterogeneity and zonation of smectites from Olduvai Gorge Locality 80. Abstracts and Program of the Annual Meeting of the Geological Society of America. Paper 267-3.

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Burke, M., Krekeler, M.P.S., Rakovan, J. (2017) An electron microscopy study of gold from Round Mountain. Abstracts and Program of the Annual Meeting of the Geological Society of America. Paper 2-2.

\*Linnekohl, S., \*Dandenault, P., \*Abbot, G., \*Hoover, A., \*Grzeskowiak, E., \*Myers, J., \*Martin, A., Burke, M., Krekeler, M.P.S. (2017) Grain characteristics and the mineralogy of modern Great Miami River sediment show complexity at Heritage Park, Colerain Township, Ohio. Abstracts and Program of the Joint Northeastern and North Central Sections of the Geological Society of America. Paper 25-17.

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Vangala, S., \*\*Dietrich, M., Burke, M., Wolfe, A., Argyilan, E.P., Krekeler, M.P.S. (2017) A preliminary field emission scanning electron microscopy (FESEM) and transmission electron microscopy (TEM) foray into the street sediments of Gary, Indiana: Major environmental health concerns are evident. Abstracts and Program of the Joint Northeastern and North Central Sections of the Geological Society of America. Paper 48-9.

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\*Breda, C., \*Herlitz, T., \*Myers, J., Krekeler, M.P.S. (2017) A geochemical and mineralogical Investigation of the Ordovician Eureka Quartzite for use as a silicon ore for Photovoltaic cells, shows promise for Plasma Furnace production. Abstracts and Program of the Joint Northeastern and North Central Sections of the Geological Society of America. Paper 25-14.

Vangala, S., \*Abbott, G., Bretz, R.L., Krekeler, M.P.S., Phosphate sorption on Kyanite: progress towards a Geoenvironmental technology to combat Non-point source pollution. Abstracts and Program of the Joint Northeastern and North Central Sections of the Geological Society of America. Paper 25-13.

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\*Osborne, T., \*Dietrich, M., \*Huling, J., \*McIntosh, K, \*Edwards, R., \*Combs, J., \*Binyam, D., Krekeler M.P.S. (2016) Urban pollution investigations of Goldman park, Middletown Ohio: Bulk Chemistry Reveals unexpected Heterogeneity in Metal Pollution. Abstracts and Program of the North Central Section of the Geological Society of America Meeting. Paper 8-4.

\*Clark, C.,\*\* Barrett, H., Krekeler M.P.S. (2016) Mineralogical investigations of black shale and siderite of the Grundy formation in northern Breathitt County, Kentucky: Environmental concerns. Abstracts and Program of the North Central Section of the Geological Society of America Meeting. Paper 8-5.

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\*\*Cymes, B.A., Krekeler, M.P.S., Nicholson K.N., Grigsby J.D. (2015) Phase diversity and potential chlorine-sulfur sequestration in nickel-phyllosilicates from New Caledonia: and An investigation using transmission electron microscopy (TEM). Abstracts and Program of the Annual Meetings of the Geological Society of America. Paper 299-19.

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\*Merrill, K., Krekeler, M.P.S., \*\*Barrett, H. (2015) An electron microscopy investigation of the heterogeneity of mineralogy of the Millbrig K-bentonite locality at Shakertown, Kentucky. Abstracts and Program of the 49<sup>th</sup> Meeting of the North Central Section of the Geological Society of America. Vol. 47,92p.

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\*\*Barrett, H., Krekeler M.P.S., \*Clark, C., \*Flett, L., \*Armentrout D. (2015) An unusual occurrence of minor precious metals in Breathitt County, Kentucky. Abstracts and Program of the 49<sup>th</sup> Meeting of the North Central Section of the Geological Society of America. Vol. 47, 92p.

\*Gander, N., Krekeler M. P.S., Gladish, D. (2015) Initial geomaterials investigations of a restored prairie on landfill cover at the Miami University Hamilton Campus. Abstracts and Program of the 49<sup>th</sup> Meeting of the North Central Section of the Geological Society of America. Vol. 47, 92p.

\*Smeltz, J., Krekeler M.P.S., Barrett, H. (2015) An industrial mineralogy investigation of varriants of recycled zinc oxide derived from spent alkaline batteries. Abstracts and Program of the 49<sup>th</sup> Meeting of the North Central Section of the Geological Society of America. Vol. 47, 92p.

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\*Richards, H., Krekeler M.P.S. (2015) An investigation of mineralogy and metal pollution from parking lot sediment at Miami University Hamilton: Implications for Storm water management. Abstracts and Program of the 49<sup>th</sup> Meeting of the North Central Section of the Geological Society of America. Vol. 47, 92p.

\*Flett, L. and Krekeler M.P.S. (2015) Investigations of Road sediment inan industrial corridor near low income housing in Hamilton Ohio indicate lead, zinc and copper contamination. Abstracts and Program of the 49<sup>th</sup> Meeting of the North Central Section of the Geological Society of America. Vol. 47, 92p.

\*\*Silverstein, J., \*\*Barrett H.A., Krekeler M.P.S. (2015) Secondary mineralization in nodular siderite laterals found in interbedded shales from Breathitt County, Kentucky. Abstracts and Program of the Southeastern Meeting of the Geological Society of America.

\*Pratschler M., \*Merrill, K., \*\*Barrett, H., \*\*Silverstein, J., Krekeler M.P.S. (2015) A preliminary investigation of materials properties of the Millbrig K-bentonite from Shakertown Kentucky: A promising material for analog shale and materials studies. Abstracts and Program of the Southeastern Meeting of the Geological Society of America.

\*Crumbaker, J., \*\*Barrett, H., Krekeler M.P.S. (2015) Initial Geomaterials investigation for developing hyper spectral remote sensing libraries for personnel recovery: Preliminary work on the lost hunter scenario. Abstracts and Program of the Southeastern Meeting of the Geological Society of America.

\*Barnes, M., \*\*Silverstein, J., Krekeler, M.P.S. (2014) Geochemical and mineralogical investigations of the Wisconsin age Glacial till of Peffer park, Oxford, Ohio: An important environmental reference material for metal pollution studies. Abstracts and Program of the Southeastern Section of the Geological Society of America Meeting. Paper 45-9.

\*Galindo, V., \*\*Burke, M., Krekeler, M.P.S. (2014) Inductively coupled plasma – optical emission spectroscopy and electron microscopy investigations of pollution in street sediment in the city of Hamilton, Ohio. Abstracts and Program of the Southeastern Section of the Geological Society of America Meeting. Paper 7-9.

\*Perme, M., Krekeler, M.P.S. (2014) Scanning electron microscopy investigation of street sediment from Akumal, a tourist village adjacent to the Meso-American Reef in the Yucatan. Abstracts and Program of the Southeastern Section of the Geological Society of America Meeting. Paper 7-8.

\*Silverstein, J., Krekeler, J., Rakovan, J. (2014) Scanning electron microscopy investigations of gold in a laterite sample from the Guyana shield of Venezuela: A Case for Authigenic Deposition. Abstracts and Program of the Southeastern Section of the Geological Society of America Meeting. Paper 40-6.

\*Chester-Paul, K., Krekeler M.P.S. (2014) Industrial mineralogy of particulate generated from ignition sources and potential human health concerns. Abstracts and Program of the Southeastern Section of the Geological Society of America Meeting. Paper 40-5.

\*Nesbitt, L., \*Kidd, M., \*Straub, K., \*Armentrout, C., \*Newby, N., \*Whitten, C., \*Sellers, A., \*\*Burke, M., \*\*Silverstein, J., Krekeler, M.P.S. (2014) Chemistry of abandoned siltation pond water and stream waters from a small abandoned wall coal mine on property in northern Breathitt County, Kentucky: A case of near attenuation. Program of the southeastern section meeting of the Geological Society of America 22-1.

\*Armetrout, C.,\*\*Burke, M.,\*\*Silverstein, J., \*Nesbit, L., \*Kidd, M., \*Straub, K., \*Newby, N., \*Whitten, C., \*Sellers, A., Krekeler, M.P.S. (2014) Unusual mineralogy ( trace silver and magnetite) and geochemistry of stream sediments from a property with 200 years of mixed use in northern Breathitt County Kentucky. Program of the southeastern section meeting of the Geological Society of America 40-8.

\*Newby, N., \*Whitten, C., \*Sellers, A., \*Gander, N., \*Armentrout, C., \*\*Silverstein, J., \*\*Burke, M., Krekeler M.P.S. (2014) Environmental Geology of property with a 200 year history of mixed use in Breathitt County Kentucky. Program of the southeastern section meeting of the Geological Society of America 7-7.



Krekeler M.P.S., \*\*Burke, M., \*\*McHugh, K., \*\*Silverstein, J., (2014) Integrating basic field skills, research and service in a 300 level geoenvironmental field class: Results from the first offering. Program of the southeastern section meeting of the Geological Society of America 38-3.

\*Baldwin, A., Bretz, R., Krekeler, M.P.S. (2014) Preliminary study of metal and anion pollution in pond waters from butler County, Ohio. Program of the southeastern section meeting of the Geological Society of America 7-5.

\*\*Burke, M., Krekeler, M.P.S., Rakovan, J.( 2014) A microtextural study of selected macrocrystalline gold samples from Nevada. Program of the southeastern section meeting of the Geological Society of America 40-7.

\*Sellers, A., Krekeler, M.P.S. (2014) Scanning electron microscopy (SEM) of non-clay mineral components of the Kope Formation and the Martinsburg Formation: Insight into environmental properties of shales. Program of the southeastern section meeting of the Geological Society of America. 44-5

\*Burke, M., Krekeler M.P.S. (2013) Transmission electron microscopy (TEM) and bulk chemical investigations of copper and associated silver from Michigan's Keweenaw Peninsula: Implications for formation and archaeological interpretations. Program of the Geological Society of America Annual Meeting, Denver, CO. Paper 62-7.

\*\* Tully, J., Krekeler, M.P.S. (2013) An inductively coupled plasma-mass spectroscopy (ICP-MS) and electron microscopy anthropogenic pollutant characterization of post-industrial Great Miami River Sediment in Hamilton Ohio. Program of the Geological Society of America Annual Meeting, Denver, CO. Paper 288-6.

\*\*Barrett H. A., Krekeler M.P.S (2012) Geologic education and assessment with a new rock and mineral specimen display. Program of the Geological Society of America Annual Meeting, Charlotte NC. Paper 29-28.

\*\*Barrett H.A, Krekeler M.P.S. (2012) Preliminary electron microscopy investigation comparing synthetic and naturally occurring cryptomelane. Program of the Geological Society of America Annual Meeting, Charlotte NC. Paper 207-11.

\*Barrett H.A., Krekeler M.P.S. (2012) Preliminary electron microscopy investigation of synthetic cryptomelane. Program of the North Central Section Meeting of the Geological Society of America, Dayton, OH. Paper 19-4.

\*\*Berhane T.M., Levy J., Krekeler M.P.S., Stalcup A. (2012) Fate and transport of carbamazepine in palygorskite-montmorillonite medium filter. Program of the North Central Section Meeting of the Geological Society of America, Dayton, OH. Paper 28-25.



\*Berhane T., Levy J., Krekeler M.P.S., Danielson N., Stalcup A. (2012) Fate (Sorption and desorption) and transport of carbamazepine in a palygorskite-montmorillonite filter medium. Program of the Geological Society of America Annual Meeting, Charlotte NC. Paper 156-23.

\*Burke A.R., Krekeler M.P.S., \*Bower. A.M. (2012) A case study in promoting geoscience at a summer children's program: Structure and operational challenges. Program of the Geological Society of America Annual Meeting, Charlotte NC. Paper 29-14

\*Burke M.L., Krekeler M.P.S. (2012) Transmission electron microscopy (TEM) investigation of silver from native copper/silver composite nugget from the Quincy Stamp Mill, Keweenaw Peninsula, northern Michigan. Program of the Geological Society of America Annual Meeting, Charlotte NC. Paper 207-10.

\*\*Daly G. E.,\*\* Sit S., Krekeler M.P.S. (2012) Encouraging awareness and appreciation of geology: Hands-on afterschool programs at the Greater Miami Valley YMCA. Program of the North Central Section Meeting of the Geological Society of America, Dayton, OH. Paper 29-4.

\*Ferraro A.K., Krekeler M.P.S. (2012) Electron microscopy captures critical mineral diversity that powder X-ray diffraction does not detect in cave sediment: An example from a cave fill in northern Kentucky. Program of the Geological Society of America Annual Meeting, Charlotte NC. Paper 163-4.

\*Kane C., Krekeler M.P.S. (2012) Preliminary mineralogical investigation of the Breathitt group sandstones of eastern Kentucky: Implications for provenance and resource studies. Program of the Geological Society of America Annual Meeting, Charlotte NC. Paper 81-11.

Krekeler, M.P.S., O'Keefe J.M.K. (2012) Transmission electron microscopy (TEM) of the < 2 micrometer size fraction of a coal ash reveals materials complexity. Program of the North Central Section Meeting of the Geological Society of America, Dayton, OH. Paper 18-4.

\*Meyer A.L., Krekeler M.P.S. (2012) Diffraction characteristics of rare earth element (REE) – Reacted synthetic cryptomelane: Complexities in a new geomaterials group. . Program of the North Central Section Meeting of the Geological Society of America, Dayton, OH. Paper 19-3.

\*Minges J.M., Krekeler M.P.S., Almquist C. (2012) The industrial mineralogy and catalytic investigation of ethanol oxidation by different types of cryptomelane and some relevant comparative materials. Program of the Geological Society of America Annual Meeting, Charlotte NC. Paper 157-35.

\*O'Malley E.G., Krekeler M.P.S. (2012) Industrial mineralogical investigation of electrolytic manganese oxide (EMD) for potential environmental applications. Program of the Geological Society of America Annual Meeting, Charlotte NC. Paper 228-32.

\*Swihart R.L., Krekeler M.P.S. (2012) Preliminary transmission electron microscopy investigation of cesium exchange with nontronite. Program of the North Central Section Meeting of the Geological Society of America, Dayton, OH. Paper 28-1.

\*Swihart R., Krekeler M.P.S. (2012) Electron microscopy investigations of selected Cs-exchanged phyllosilicates at low and high temperatures: Implications for remediation of nuclear accidents. Program of the Geological Society of America Annual Meeting, Charlotte NC. Paper 2-11.

\*Thrailkill A.M., Almquist C., Krekeler M.P.S. (2012) A Comparative Investigation of metal sorption using a variety of manganese oxide materials derived from various sources: Implications for industrial mineralogy and geotechnology development. Program of the Geological Society of America Annual Meeting, Charlotte NC. Paper 228-35.

\*\*Tselepis-Loertscher C., Rakovan J., Krekeler M.P.S. (2012) Investigation of heterogenous oxidation of manganese(II) and oxide formation on natural and synthetic goethite. Program of the North Central Section Meeting of the Geological Society of America, Dayton, OH. Paper 19-7.

\*\*Tully J.L., Krekeler M.P.S. (2012) A preliminary scanning electron microscopy (SEM) investigation of great Miami river sediment from heritage park in southwestern Ohio. Program of the North Central Section Meeting of the Geological Society of America, Dayton, OH. Paper 18-5.

\*\*Tully J.L., \*\*Barrett H.A., \*\*Sit S., Krekeler M.P.S. (2012) Developing and fostering scientific literacy through youth programs at the YMCA. Program of the Geological Society of America Annual Meeting, Charlotte NC. Paper 29-15.

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\*Waldecker H.S., Krekeler M.P.S. (2012) Heavy metal analysis and geochemistry of sediment on the Great Miami River in Hamilton, Ohio. Program of the Geological Society of America Annual Meeting, Charlotte NC. Paper 2-4.

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\*Burke M., Fischer T.B., Krekeler M.P.S. (2011) Transmission electron microscopy (TEM) investigations reveal microtexture and nanotexture complexity in native Copper from Northern Michigan's Keweenaw Peninsula. Program of the Geological Society of America Annual Meeting, Minneapolis, MN. Paper 247-1.

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\*Ferraro A.K., \*Meyer A.L., \*Burnette C.S., Barrett H.A., Krekeler M.P.S. (2011) Environmental Mineralogy and geochemistry of some spent alkaline batteries from a representative waste stream, Butler County, Ohio: Implications for landfill leachate. Abstracts and Program of the Geological Society of America Annual Meeting, Minneapolis, MN. Paper 241-20.

Fischer T.B., Dong, H., Krekeler M.P.S. (2011) Using transmission electron microscopy (TEM) in geoscience education at the undergraduate and graduate levels. Abstracts and Program of the Geological Society of America Annual Meeting, Minneapolis, MN. Paper 114-9.

\*LeGalley E., Krekeler M.P.S., Widom E., Kuentz D.C. (2011) Using electron microscopy and isotopic geochemistry to assess particulate pollution in street sediment near a coal-fired power plant in Hamilton, Ohio. Abstracts and Program of the Geological Society of America Annual Meeting, Minneapolis, MN. Paper 166-4.

\*LeGalley, E., Widom, E., Krekeler M.P.S., Kuentz D.C. (2011) Source of lead contamination in street sediment in southwest Ohio, USA: Constraints from lead isotopes [abstract]. In: 9<sup>th</sup> International Symposium on Applied Isotope Geochemistry Program p. 25 (Catalonia, Spain).

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\*Morrow S. L., \*Fenner-Aubin W.M., Krekeler M.P.S. (2011) Afterschool geoscience activities for underprivileged African-American 7<sup>th</sup> and 8<sup>th</sup> Graders at the YMCA in the City of Hamilton, Butler County, Ohio. Abstracts and Program of the Geological Society of America Annual Meeting, Minneapolis, MN. Paper 171-1.

\*LeGalley, E.M., Krekeler M.P.S. (2010) Heavy metal concentrations and environmental mineralogy of street sediment in a community near a coal plant in Hamilton, Ohio. Abstracts and Program of the Northeastern Section (45th Annual) and Southeastern Section (59th Annual) Joint Meeting (13-16 March 2010) of the Geological Society of America. Paper 42-2.

\*Schellenbach W.L., Krekeler, M. P.S. (2010) Mineralogical and geochemical investigation of pyrite-rich mine waste from a kyanite mine in central Virginia. Abstracts and Program of the Northeastern Section (45th Annual) and Southeastern Section (59th Annual) Joint Meeting (13-16 March 2010) of the Geological Society of America. Paper 79-20.

\*Barrett H.A., Krekeler M.P.S. (2010) Transmission electron microscopy (TEM) investigation of industrial mineralogy of anodic battery waste. Abstracts and Program of the Northeastern Section (45th Annual) and Southeastern Section (59th Annual) Joint Meeting (13-16 March 2010) of the Geological Society of America. Paper 79-28.

\*Fenner-Aubin W., Krekeler, M.P.S. (2010) Evaluation of mapping Exercises for adult job training in Hamilton, Ohio. Abstracts and Program of the Northeastern Section (45th Annual) and Southeastern Section (59th Annual) Joint Meeting (13-16 March 2010) of the Geological Society of America. Paper 38-11.

Krekeler, M.P.S., Allen C.S., \*Schellenbach W.L., \*LeGalley, E.M., \*Geise, G. (2010) Mineralogical and Geochemical Investigations of three waste streams from a kyanite mine in central Virginia: Implications for recycling in an economically disadvantaged region. Abstracts and Program of the annual meeting of the Geological Society of America. Paper 157-11.

\*LeGalley, E.M., Krekeler, M.P.S. (2010) Electron microscopy investigation of street sediment reveals complexities of coal pollution in Hamilton, OH: Cause for health concerns. Abstracts and Program of the annual meeting of the Geological Society of America. Paper 258-7.

\*Wainer, R.C., \*Schellenbach W.L., \*Burnette, C., \*Chance, D., \*McDonald, A. (2010) A mineralogical investigation of an outcrop of the Berea sandstone within the serpent mound structure, southwestern Ohio. Abstracts and Program of the annual meeting of the Geological Society of America. Paper 31-6.

Allen, C.S., Krekeler M.P.S. (2010) The development of a reflectance spectral library for crude oil and refined petroleum product detection on terrestrial substrates. Abstracts and Program of the annual meeting of the Geological Society of America. Paper 276-10.

\*Burke, M., Krekeler M.P.S. (2010) Scanning electron microscopy investigation of native copper samples from the Keweenaw peninsula reveals unexpected mineral diversity. Abstracts and Program of the annual meeting of the Geological Society of America. Paper 31-8.

\*Burnette, C.S., \*Schellenbach W.L., \*Wainer R.C., \*Chance D.,\* McDonald, A., \*Krekeler M.P.S. (2010) Mineralogical investigations of a meteorite impact breccias from the serpent mound archaeological site, Adams County, Ohio. Abstracts and Program of the annual meeting of the Geological Society of America. Paper 35-13.

\*Barrett, H.A., Krekeler, M.P.S. (2009) Environmental mineralogical investigations of anodic portions of some spent alkaline batteries. Abstracts and Program of the Annual Meeting of the Geological Society of America. Paper 243-14.

\*Calkins, K. C. and Krekeler M. P.S.(2009) Investigations of an unconsolidated Pleistocene Limestone unit for use in subsurface flow constructed wetlands in the Yucatán. Abstracts and Program of the Annual Meeting of the Geological Society of America. Paper 243-16.

\*Geise, G.R., Krekeler, M.P.S. (2009) Investigation of mineralogical and geochemical properties of silicate-rich mine waste from a Kyanite mine in central Virginia. Abstracts and Program of the Annual Meeting of the Geological Society of America. Paper 243-9.

Hutnik, J.J., Aldridge, D. E., \*\*Tselepis, C.M., Krekeler, M.P.S. (2009) First occurrence of silver, gold and platinum in the Yucatán. Abstracts and Program of the Annual Meeting of the Geological Society of America. Paper 226-11.

Krekeler, M.P.S. (2009) Mineralogical investigations of cathodic regions of disposable spent alkaline batteries. Abstracts and Program of the Annual Meeting of the Geological Society of America. Paper 31-4.

Krekeler, M.P.S. (2009) Examining the potential for improved wetland design and efficiency in Akumal, Mexico using local geomaterials. Abstracts and Program of the 43<sup>rd</sup> Meeting of the North-Central Section of the Geological Society of America. Paper 11-4.

\*LeGalley, E.M., Krekeler, M.P.S. (2009) Grain size characteristics of silica-rich mine waste from a Kyanite mine in Dillwyn, Virginia. Abstracts and Program of the Annual Meeting of the Geological Society of America. Paper 243-10.

Varma, S.R., Krekeler, M.P.S. (2009) Investigation of thirty subsurface flow constructed wetlands in Akumal, Mexico. Abstracts and Program of the Annual Meeting of the Geological Society of America. Paper 218-3.

Adams, J.P., Kirst, R., Krekeler, M.P.S. (2008) Mn-oxides and sequestration of heavy metals in a suburban catchment basin of the Chesapeake Bay water shed. Abstracts and Program of Annual Meeting of the Geological Society of America. Paper 247-20.

DeLanoy, J. T., Schneider, A., Krekeler, M.P.S. (2008) Investigation of a potential mineral-based control agent. Abstracts and Program of Annual Meeting of the Geological Society of America. Paper 139-5.

Hutnik, J. J., Krekeler, M.P.S., Kearns, L.E. (2008) Investigations of an aggregate resource for constructed wetland use near the city of Valladolid, Yucatan, Mexico. Abstracts and Program of Annual Meeting of the Geological Society of America. Paper 247-48.

Kearns, C.A., Kearns, L.E., Oksanen, M. F., Stewart, R. E., Krekeler, M.P.S. (2008) Veinlet mineralogy and chemistry in a nepheline syenite Dike, Augusta County, Virginia. Abstracts and Program of Annual Meeting of the Geological Society of America. Paper 193-23.

Krekeler, M.P.S. Kearns, C.A., Kysar-Mattietti, G., Wise, M., Kearns L. E. (2008) Mineralogical investigation of a 42 Ma Anorthoclase-rich Dike, Pendleton County, West Virginia. Abstracts and Program of Annual Meeting of the Geological Society of America. Paper 193-22.

Kysar-Mattietti G., Krekeler, M.P.S., Arnold, D.E. Neff, H., Glascock M.D., Speakman R.J. (2008) Geochemical Investigation of palygorskite-rich units in the central Yucatan. Abstracts and Program of Annual Meeting of the Geological Society of America. Paper 193-25.

Raveia, M. A., Hendrickson S. B., Fitzgerald, J.T., Krekeler, M.P.S., Kearns, L.E. (2008) Investigations of impurities of the Ottwa standard sand. Abstracts and Program of Annual Meeting of the Geological Society of America. Paper 247-35.

Renaud, K. M., Krekeler, M.P.S., Kearns, L.E. (2008) Investigations of luminescent and phosphorescent calcite from the Middle Ordovician Tumbling Run section, Strasburg Virginia, USA. Abstracts and Program of Annual Meeting of the Geological Society of America. Paper 193-30.

Roberts, S., Krekeler M.P.S. (2008) Investigations of mixed media for use in constructed wetlands in the eastern Yucatan. Abstracts and Program of Annual Meeting of the Geological Society of America. Paper 247-52.

Samsonov, M, and Krekeler M. P. S. (2008) Investigation of a Clay-rich Aggregate for use in constructed wetlands in the Eastern Yucatan. Abstracts and Program of Annual Meeting of the Geological Society of America. Paper 247-49.

Morton, J., Krekeler, M.P.S., and Lepp, J. (2007) Environmental Aspects of Phosphate Mine Tailings in Florida: A Review. Abstracts and Program of the 42nd Annual Meeting of the Northeastern Section of the Geological Society of America.



Lepp, J., Tselepis, C. M., Samsonov, M., Morton, J., Krekeler, M.P.S., Kearns, L.E. (2007) Stratigraphy and Bulk Properties of a Deposit of Clay-Rich Mine Tailings from a Closed Phosphate Mine near Bartow, Florida. Abstracts and Program of the 42nd Annual Meeting of the Northeastern Section of the Geological Society of America.

Krekeler, M.P.S., Tseleips, C.M., Morton, J., Samsonov, M., Lepp, J., and Kearns, L.E. (2007) Investigations of Phyllosilicates in Clay-Rich Mine Tailings from a Closed Phosphate Mine near Bartow Florida. Abstracts and Program of the 42nd Annual Meeting of the Northeastern Section of the Geological Society of America.

Samsonov, M., Morton, J., Tselepis, C.M., Lepp, J., Krekeler, M.P.S., and Kearns, L.E. (2007) Phosphate Minerals in Clay-Rich Mine Tailings from a Closed Phosphate Mine near Bartow Florida. Abstracts and Program of the 42nd Annual Meeting of the Northeastern Section of the Geological Society of America.

Moody, A.H., Tselepis, C. M., and Krekeler, M.P.S. (2007) Preliminary Clay Mineralogy Investigations of Sediment from a Suburban Catchment Basin in the George Mason University Ecological Observatory. Abstracts and Program of the 42nd Annual Meeting of the Northeastern Section of the Geological Society of America.

Long, B., Krekeler, M.P.S., Kearns, L.E., Maynard, J.B. (2006) Investigation of Mine Waste from a Kyanite Mine in Virginia: A Case for Waste Recycling. Abstracts and Program of the Geological Society of America Annual Meeting, Philadelphia, PA.

Stoll, D. Samsonov, M., Raoufina, N., Tselepis, C.M., Lepp, J., Jonas, R., Krekeler, M.P.S. (2006) Preliminary Ecological Investigations of E.Coli Interactions with Aqueous Suspensions of Na-Montmorillonite, Illite, and Palygorskite. Abstracts and Program of the Geological Society of America Annual Meeting, Philadelphia, PA.

Cone, K., Krekeler, M.P.S., Diecchio, R. J., Kearns, L. E. (2006) Investigations of Diagenesis of Phosphatic Sediments in the Ordovician Reedsville Formation near the Allegheny Front in Pendleton County, West Virginia. Abstracts and Program of the Geological Society of America Annual Meeting, Philadelphia, PA.

Samsonov, M., Tselepis, C.M., Krekeler, M. P. S., Maynard, J.B., Kearns, L.E., (2006) Investigations of Geologic Materials in Constructed Wetlands Akumal, Quintana Roo, Mexico. Abstracts and Program of the Geological Society of America Annual Meeting, Philadelphia, PA.

Tselepis, C.M., Gillevet, P., Krekeler, M.P.S. (2006) Investigations of Oxides and Diversity of Bacteria in Soil Horizons Developed in Holocene Beach Ridges, Tahquamenon Bay, Michigan. Abstracts and Program of the Geological Society of America Annual Meeting, Philadelphia, PA.

Tselepis, C. M. and M.P.S. Krekeler (2005) Investigation of a Synthetic Soil for Created Wetland Enhancement. Annual Geological Society of America Meeting. (Poster) Denver, CO.



Elmore, S. and M.P.S. Krekeler (2005) An Investigation of Cs-phyllosilicates for Nuclear Waste Management. Annual Geological Society of America Meeting. (Poster) Denver, CO.

Caballero, R. P., Shankle, C. E. N., Krekeler, M.P.S., Ahn, C. (2005) Investigation of Soils in a Created Wetland near Haymarket, Virginia. Abstracts and Program of the Geological Society of America Annual Meeting. Denver, CO.

Krekeler, M.P.S., Rakovan, J., Guggenheim, S. (2004) Polysome-Width Variation in Palygorskite-Sepiolite Minerals: A TEM and AFM Investigation of Structural Variation and Transformation. Abstracts and Program of the Geological Society of America Annual Meeting, Denver, CO.

## Teaching Experience

Undergraduate Level: GLG 411 Field Camp

GLG 311 Geoenvironmental field methods

GLG 244 Oceanography,

GLG 307 Water and Society,

GLG 220 Mineralogy - GMU

UNV 177 First Year Research Experience GLG 111 Introductory Geology

GLG 177 Introduction to Historical Geology – GMU

GLG 121 Environmental Geology

GLG 115L Understanding the Earth

Undergraduate /  
Graduate Level:

GLG 470 / 501 Geochemistry,

GLG 330 / 501 Soil Science,

GLG 488 / 601 Clay Science (GMU courses)

Graduate Level:

GLG 710 Transmission Electron Microscopy,

GLG 710 Smectite Minerals,

GLG 677 Shales,

ENV 720 Dissertation and Thesis Proposal Preparation - GMU

ENV 720 Green Technologies – GMU

## Service

2016

Expert witness for battery recycling patent infringement case Scarfone-Hawkins Canada.

2015 – Present

Pro Bono mineralogical analysis for Kinross USA,

2016 – Present

Pro Bono mineralogical analysis for OMYA,

2006 – 15

Pro Bono mineralogical analysis for Kyanite Mining Corporation

2012 - 17	Ross Middle School / Elementary and Fairfield Middle School Geology demonstration days.
2016	Math and Physical Sciences search committee for department chair.
2016-17	Math and Physical Sciences search committee for Assistant professor of Physics
2012	Geology department search committee for lecturer – Miami University Middletown campus
2008 – Present	Advisor geology program Miami University Hamilton
2003 – Present	Reviewer for Environmental Earth Sciences, Carbonates and Evaporates, Applied Clay Science

# EXHIBIT

# B

## Materials and Data Considered

### A. Literature

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#### **B. Documents (By Bates Number)**

IMERYS 427428	IMERYS 427326	IMERYS 427419	IMERYS 436951	IMERYS 418940	IMERYS 435988
IMERYS 435992	IMERYS 435996	IMERYS 436000	IMERYS 238270	IMERYS 436951	IMERYS 427291
IMERYS 235927	IMERYS 238879	IMERYS 077321	IMERYS 245144	IMERYS 467511	IMERYS 334779
IMERYS 117598	IMERYS 061692	IMERYS 425354	IMERYS 034115	IMERYS 030231	IMERYS 032139
IMERYS 034036	IMERYS 061692	IMERYS 413792	IMERYS 415991	IMERYS 416007	IMERYS 418940
IMERYS 173933	IMERYS 240978	IMERYS 210824	IMERYS 210700	IMERYS 210701	IMERYS 210810- 210812
IMERYS 210801- 210803	IMERYS 210794	IMERYS 210788- 210799	IMERYS 210758	IMERYS 210724	IMERYS 477879

IMERYS 219720	IMERYS 435992	IMERYS 213431	IMERYS 422289	IMERYS 304036	IMERYS 342524
IMERYS 094601	IMERYS 045184	IMERYS 045182	IMERYS 053387	IMERYS 340454	IMERYS 340798
IMERYS 286445	IMERYS 048393	IMERYS 068482	IMERYS 430826	IMERYS 430850	IMERYS 430856
IMERYS 430862	IMERYS 430892	IMERYS 474851	IMERYS 120012	IMERYS 481989	IMERYS 481874
IMERYS 475372	IMERYS 475275	IMERYS 426677	IMERYS 427423	IMERYS 427428	IMERYS 426681
IMERYS 426685	IMERYS 427429	IMERYS 436972	IMERYS 436979	IMERYS 436976	IMERYS 136928
IMERYS 045194	IMERYS 045199	IMERYS 225111	IMERYS 189001	IMERYS 229069	IMERYS 046877
IMERYS 069210	IMERYS 093711	IMERYS 195291	IMERYS 033627	IMERYS 051436	IMERYS 051442
IMERYS 130504	IMERYS 238132	IMERYS 442232	IMERYS 500801	IMERYS 051370	IMERYS 499486
IMERYS 445919	IMERYS 210707	IMERYS 053387	IMERYS 051371	IMERYS 499264	IMERYS 442232
IMERYS 210810	IMERYS 238474	IMERYS 238468	IMERYS 238457	IMERYS 211157	
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JNJNL61_ 000006792					
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JOJO-MA2330	JOJO-MA90013				
J&J-309	J&J-310	J&J-1	J&J-311	J&J-2	J&J-313
J&J-9	J&J-257	J&J-255	J&J-256	J&J-15	J&J-19
J&J-23	J&J-28	J&J-342	J&J-373	J&J-29	J&J-348
J&J-31	J&J-36	J&J-34	J&J-37	J&J-263	J&J-33
J&J-100	J&J-296	J&J-44	J&J-327	J&J-335	J&J-367
J&J-368	J&J-47	J&J-299	J&J-258	J&J-263	J&J-57
J&J-58	J&J-65	J&J-66	J&J-360	J&J-370	J&J-74
J&J-75	J&J-89	J&J-92	J&J-297	J&J-97	J&J-303
J&J-141	J&J-246	J&J-164	J&J-341	J&J-202	J&J-169
J&J-175	J&J-305	J&J-179	J&J-177	J&J-182	J&J-184
J&J-190	J&J-0144301	J&J-0007797	J&J-0007801	J&J 000797	

### C. Depositions & Exhibits

1. Deposition and Transcript of Alice Blount, April 13, 2018.
2. Deposition and Transcript of Donald Hicks, June 28, 2018.
  - a. Hicks 01
  - b. Hicks 02
  - c. Hicks 03
  - d. Hicks 04
  - e. Hicks 05
  - f. Hicks 06
  - g. Hicks 07
  - h. Hicks 08
  - i. Hicks 09
  - j. Hicks 10
  - k. Hicks 11
  - l. Hicks 12
  - m. Hicks 13
  - n. Hicks 14
  - o. Hicks 15
  - p. Hicks 16
  - q. Hicks 17

- r. Hicks 18
  - s. Hicks 19
  - t. Hicks 20
  - u. Hicks 21
  - v. Hicks 22
  - w. Hicks 23
  - x. Hicks 24
  - y. Hicks 25
  - z. Hicks 26
  - aa. Hicks 27
  - bb. Hicks 28
  - cc. Hicks 29
  - dd. Hicks 30
  - ee. Hicks 31
  - ff. Hicks 32
3. Deposition and Transcript of Donald Hicks, June 29, 2018.
- a. Hicks 33
  - b. Hicks 34
  - c. Hicks 35
  - d. Hicks 36
  - e. Hicks 37
  - f. Hicks 38
  - g. Hicks 39
  - h. Hicks 40
  - i. Hicks 41
  - j. Hicks 42
  - k. Hicks 43
  - l. Hicks 44
  - m. Hicks 45
  - n. Hicks 46
  - o. Hicks 47
  - p. Hicks 48
  - q. Hicks 49
4. Deposition and Transcript of Patrick Downey, August 7, 2018.
- a. Downey 01
  - b. Downey 02
  - c. Downey 03
  - d. Downey 04
  - e. Downey 05
  - f. Downey 06



- g. Downey 07
  - h. Downey 08
  - i. Downey 09
  - j. Downey 10
  - k. Downey 11
  - l. Downey 12
  - m. Downey 13
  - n. Downey 14
  - o. Downey 15
  - p. Downey 16
  - q. Downey 17
  - r. Downey 18
  - s. Downey 19
  - t. Downey 20
  - u. Downey 21
  - v. Downey 22
  - w. Downey 23
5. Deposition and Transcript of Patrick Downey, August 8, 2018.
- a. Downey 24
  - b. Downey 25
  - c. Downey 26
  - d. Downey 27
  - e. Downey 28
  - f. Downey 29
  - g. Downey 30
  - h. Downey 31
  - i. Downey 32
  - j. Downey 33
  - k. Downey 34
  - l. Downey 35
  - m. Downey 36
  - n. Downey 37
  - o. Downey 38
  - p. Downey 39
  - q. Downey 40
  - r. Downey 41
  - s. Downey 42
  - t. Downey 43
  - u. Downey 44
  - v. Downey 45

- w. Downey 46
  - x. Downey 47
  - y. Downey 48
  - z. Downey 49
  - aa. Downey 50
  - bb. Downey 51
  - cc. Downey 52
  - dd. Downey 53
  - ee. Downey 54
  - ff. Downey 55
  - gg. Downey 56
  - hh. Downey 57
  - ii. Downey 58
  - jj. Downey 59
  - kk. Downey 60
  - ll. Downey 61
  - mm. Downey 62
  - nn. Downey 63
  - oo. Downey 64
6. Deposition and Transcript of Julie Pier, September 12, 2018.
- a. Pier 01
  - b. Pier 02
  - c. Pier 03
  - d. Pier 04
  - e. Pier 05
  - f. Pier 06
  - g. Pier 07
  - h. Pier 08
  - i. Pier 09
  - j. Pier 10
  - k. Pier 11
7. Deposition and Transcript of Julie Pier, September 13, 2018.
- a. Pier 12
  - b. Pier 13
  - c. Pier 14
  - d. Pier 15
  - e. Pier 16
  - f. Pier 17
  - g. Pier 18
  - h. Pier 19

- i. Pier 20
- j. Pier 21
- k. Pier 22
- l. Pier 23
- m. Pier 24
- n. Pier 25
- o. Pier 26
- p. Pier 27
- q. Pier 28
- r. Pier 29
- s. Pier 30
- t. Pier 31
- u. Pier 32
- v. Pier 33
- w. Pier 34
- x. Pier 35
- y. Pier 36
- z. Pier 37
- aa. Pier 38
- bb. Pier 39
- cc. Pier 40
- dd. Pier 41
- ee. Pier 42
- ff. Pier 43
- gg. Pier 44
- hh. Pier 45
- ii. Pier 46
- jj. Pier 47

8. Deposition and Transcript of John Hopkins, August 16, 2018

- a. Hopkins 01
- b. Hopkins 02
- c. Hopkins 03
- d. Hopkins 04
- e. Imerys 05
- f. JJ 01
- g. JJ 02
- h. JJ 04
- i. JJ 09
- j. JJ 100

k. JJ 121  
l. JJ 141  
m. JJ 142  
n. JJ 154  
o. JJ 157  
p. JJ 158  
q. JJ 159  
r. JJ 164  
s. JJ 169  
t. JJ 17  
u. JJ 177  
v. JJ 179  
w. JJ 182  
x. JJ 185  
y. JJ 19  
z. JJ 194  
aa. JJ 198  
bb. JJ 200  
cc. JJ 201  
dd. JJ 207  
ee. JJ 211  
ff. JJ 213  
gg. JJ 224  
hh. JJ 228  
ii. JJ 23  
jj. JJ 234  
kk. JJ 241  
ll. JJ 252  
mm. JJ 255  
nn. JJ 256  
oo. JJ 257  
pp. JJ 258  
qq. JJ 263  
rr. JJ 28  
ss. JJ 29  
tt. JJ 33  
uu. JJ 34  
vv. JJ 35  
ww. JJ 36  
xx. JJ 44

yy. JJ 47

zz. JJ 49

aaa. JJ 57

bbb. JJ 58

ccc. JJ 65

ddd. JJ 69

eee. JJ 74

fff. JJ 89

ggg. JJ 92

hhh. JJ 93

9. Deposition and Transcript of John Hopkins, August 17, 2018

a. Hopkins 09

b. Hopkins 10

c. Hopkins 11

d. Hopkins 12

e. Hopkins 13

f. Hopkins 14

g. Hopkins 15

h. Hopkins 18

i. Hopkins 19

j. Hopkins 20

k. Hopkins 21

l. Hopkins 23

m. Hopkins 24

n. JJ 10

o. JJ 105

p. JJ 107

q. JJ 108

r. JJ 11

s. JJ 111

t. JJ 112

u. JJ 14

v. JJ 15

w. JJ 175

x. JJ 18

y. JJ 184

z. JJ 190

aa. JJ 202

bb. JJ 216

cc. JJ 217

- dd. JJ 219
  - ee. JJ 220
  - ff. JJ 221
  - gg. JJ 230
  - hh. JJ 246
  - ii. JJ 253
  - jj. JJ 26
  - kk. JJ 262
  - ll. JJ 267
  - mm. JJ 31
  - nn. JJ 38
  - oo. JJ 39
  - pp. JJ 46
  - qq. JJ 60
  - rr. JJ 66
  - ss. JJ 75
  - tt. JJ 77
  - uu. JJ 87
  - vv. JJ 90
  - ww. JJ 95
  - xx. JJ 97
10. Deposition and Transcript of John Hopkins, August 18, 2018
- a. Hopkins 28
  - b. Hopkins D-1-AA
  - c. Hopkins JJ-188
  - d. Hopkins JJ-335
  - e. Hopkins JJ-345
  - f. Hopkins JJ-346
  - g. Hopkins JJ-348
  - h. Hopkins JJ-350
  - i. Hopkins JJ-352
  - j. Hopkins JJ-357
  - k. Hopkins JJ-366
  - l. Hopkins JJ-367
  - m. Hopkins JJ-368
  - n. Hopkins JJ-369
  - o. Hopkins JJ-370
  - p. Hopkins JJ-373
  - q. Hopkins JJ-374
  - r. Hopkins JJ-376

**D. Expert Reports**

1. Longo, W.E. and Rigler, M.W., The Analysis of Johnson & Johnson's Historical Baby Powder & Shower to Shower Products from the 1960's to the Early 1990's for Amphibole Asbestos, Materials Analytical Services, LLC. (Nov. 14, 2018)
2. Longo, W.E. and Rigler, M.W., TEM Analysis of Historical 1978 Johnson's Baby Powder Sample for Amphibole Asbestos, Materials Analytical Services, LLC. (Feb. 16, 2018).
3. Longo, W.E. and Rigler, M.W., Analysis of Johnson & Johnson Baby Powder & Valiant Shower Talc Products for Amphibole (Tremolite) Asbestos, Materials Analytical Services, LLC. (Aug. 2, 2017).
4. Longo, W.E. and Rigler, M.W., MAS Project # 14-1683, Johnson's Baby Powder Sample Set, Materials Analytical Services, LLC. (Apr. 28, 2017).